White Paper Report

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Institution: Abbe Museum

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White Paper Report

Grant No. PF-50034-10

Planning for a Sustainable Preservation Environment for Collections

Project Director: Ms. Julia Clark

Grantee Institution: Abbe Museum

Date: March 29, 2013

Narrative

As a collecting institution, the Abbe Museum focuses on Maine's four Native American tribes: the Penobscot, Passamaquoddy, Micmac and Maliseet, collectively known as the Wabanaki. Operating from two public facilities, the mission of the Abbe Museum is *to inspire new learning about the Wabanaki Nations with every visit.* The Museum's collections, exhibitions, and programs focus on Native American traditions in Maine and explore the broader Native American experience, past and present. The Museum's collections management policy and collecting plan limit our permanent collection to Wabanaki related artifacts and archives, while we have more flexibility in exhibitions and programs to explore a broader range of Native American cultures and issues.

In September 2001, the new Abbe Museum in downtown Bar Harbor opened its doors to the public. There was a great deal of excitement about this new facility, a second location for the museum that was originally founded in 1928. One of the most exciting things about the new facility was that it provided for state-of-the-art collections storage and exhibits. From the original building with its old electric heat, portable dehumidifiers and fans, we were now in a brand new space with a big, complex HVAC system that would provide a level of temperature and humidity control not possible before. The goal was to achieve the 70˚F/50% RH that loan agreements from major museums around the country required to borrow objects. We were told that our well-lit, spacious collections storage space, with its preservation-quality compact storage system would provide ideal conditions for the long-term care of our collections! We updated our AAM Standard Facilities Reports with the new temperature and humidity parameters given to us by the environmental engineers, while the system was being completed.

Then we installed new HOBO data loggers and started to monitor conditions prior to moving collections into the space, and before we installed any exhibits with objects, especially loans. Our excitement about the new climate control system was short-lived. This was the beginning of almost a decade of frustrations, challenges, equipment failures, un-met expectations, high costs and much more learning about HVAC systems than we had ever expected. Rarely were we able to accomplish the treasured 70/50 the loan agreements asked for and our engineers told us the system would provide. While conditions in the below-grade, single-story and rarely occupied collections storage space were really close most of the time, the much larger main exhibit gallery, a two- story open space with many exterior walls and roof, brightly lit with halogen track lighting and populated with museum visitors, was almost never on target. And that was when all the components of the system were up and running. But then the chiller would break down, or a boiler, or the humidifier, or a fan in the air handler, and our data logger charts would shift from looking like the Appalachians to more like the Himalayas. Records many pages long were created documenting every problem, the attempted solutions, and follow-up.

Over the many years of trying to fix the climate control system, faulty or incorrect mechanical components of the system were identified and replaced, settings were constantly tweaked, new service providers would come in to learn the systems and become familiar with museum climate control goals and the expectations of Abbe staff. It was often a challenge to determine why our dataloggers were recording one set of temperature and humidity readings, when the system controls were telling us something different. In 2003, Facility Dynamics, an engineering firm specializing in building commissioning and controls consulting, did a partial evaluation of the HVAC system, identifying several problems and proposing solutions. Most of these solutions were carried out, with moderate success, but others were beyond the funding resources available at the time.

The other challenge we were facing throughout this time was that the cost of operating the system was much higher than we had expected. We were using almost as much heating oil in July (reheating air cooled to dehumidify it) as we were in January, and the chiller was running through much of the winter (to cool down the air heated by the steam humidification, or so we thought). The frequent breakdowns meant frequent visits from service providers, and often it took longer than we expected to fix problems, either because a new service tech was not familiar with the specifics of our system, or because parts were not locally available to make the necessary repairs. It was frustrating to be spending so much to maintain what was essentially a brand new facility, instead of focusing resources on exhibits, educational programs, and other mission-related activities.

In 2009, under new leadership, the Abbe identified the NEH's Sustaining Cultural Heritage Collections grant as an opportunity to take a more comprehensive look at our building systems, with the complementary goals of improving the performance of these systems while also making their operation more sustainable, both environmentally and financially. As a critical component of overall institutional health, these goals were included in the Abbe's 2010-2014 Strategic Plan: "Strategic Objective 10: Maintain and improve facilities and infrastructure to support essential programs and to promote long-term sustainability. Tactical Step (a) Analyze the existing climate control systems and examine passive and low-energy alternatives." To help accomplish this, the Abbe applied for a planning grant in 2009, and was awarded the grant in 2010. Planning grant activities were completed from 2010 through 2012, and we are already well into the implementation process, starting with funds raised from private donors, and we have applied for an NEH implementation grant to help tackle several of the remaining steps.

Project Activities

The goal of the proposed planning project was to take a system-wide approach to fully evaluate the climate control system, determine its true capabilities, and look at where there may be room for improvement. The re-evaluation of targets for temperature and humidity aimed to apply new research in museum collections care, as well as taking into better account the highly variable natural environment of an island on the coast of Maine. The project also considered and recommended environmentally and economically sustainable approaches to the building environment.

The project began with the analysis of temperature and relative humidity data collected during the year prior to the start of the project. Data collected from five HOBO data loggers in the collections spaces in the museum over a year-long period in 2009-2010 were analyzed by Watson & Henry Associates and sub-consultant Wendy Jessup and Associates, and the results were compared to industry standards. The standards used for this analysis can be found in Table 3, Chapter 21, *Museums, Galleries, Archives and Libraries* of the 2007 *Applications Handbook* of the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE). The details of this analysis can be found in Appendix A.

To summarize, it was found that based on the capabilities of the HVAC and related systems, and the facility's building envelope, we should be able to achieve Control Class A (Float RH), the second highest level of control. In fact, with the primary exception of variations that resulted from an extended failure of the humidification system during the time period under consideration, the system actually achieved this target, or even Class AA, the highest level, during periods of stable exterior conditions. Failure of system components was identified as the key weak point that led to spaces only achieving Class D conditions when break-downs occurred.

Probably the biggest surprise for Abbe Museum staff was to see what exactly the engineering industry standards actually were, compared to what we had been led to expect, and compared to what is often required by museum loan agreements. The fact that our system was, most of the time, easily meeting a very acceptable level of control, was a pleasant surprise. The disconnect between what engineers and many in the conservation field tell us is OK and what loan agreements require has been highlighted as part of ongoing discussions and research in the museum and conservation fields, and played an important part in improving our understanding of what to expect and what variations were acceptable.

The second phase of the evaluation process consisted of a site visit in April 2011. Consulting architect/engineer Michael Henry and conservator Ronald Harvey were on site for three days, and the engineer from our HVAC service provider was on site for two days. In addition, the architect for the 2001 facility, Jonathan Traficonte of Schwartz/Silver Architects, participated in the one-day workshop on the final day of the site visit.

The site visit allowed the project consultants to evaluate the various building systems from top to bottom, take real-time measurements of performance, work with the service provider's engineer to assess the controls systems, and begin to develop a set of recommendations to move forward. The participation of an individual from our service provider was critical to the success of the project, as it allowed the consultants to identify realistic and do-able steps that would work with the building systems in place. They were also able to do some experimentation with control settings to further the evaluation process.

The workshop was held on the final day of the site visit, and brought together the consultants, the service provider, the architect and the key Abbe Museum staff members to learn about the results of the evaluation, and to begin discussing and considering next steps. This was an excellent format, as it allowed all of the necessary stakeholders to have input, ask questions, and contribute to solutions. Abbe staff found that this inclusive process resulted in well-informed, manageable solutions to problems we had been frustrated with for a decade.

The results of the evaluation are detailed in the *Environmental Improvements Report* provided by Michael Henry and Ronald Harvey, attached as Appendix A. The results will be briefly summarized here.

In addition to determining, based on previously collected temperature and relative humidity data, that the building's HVAC system was capable of performing, and often did perform at a Class A (float RH) level, and sometimes higher, three key strategies were developed to guide implementation of a sustainable collections environment for the Abbe Museum:

1. Lighting and electrical improvements for reduced energy consumption
2. Passive measures for interior environmental stability to reduce demand on the environmental management (HVAC) system
3. Environmental management (HVAC) system improvements for improved efficiency and reduced energy consumption (electricity and fuel oil)

It is important to note that the strategies do not involve tightening of the target Class of Control for the collections spaces of the Abbe Museum; on the contrary, implementation of the actions, particularly those which buffer the relative humidity of stored and exhibited collections, will effectively reduce the impact of fluctuations in the space conditions on the vulnerable collections objects. Ultimately, short term fluctuations in relative humidity may be less critical to the collections if vulnerable objects are well-buffered in storage housings or exhibit vitrines.

Lighting and Electrical Improvements

Easily the biggest surprise for the Abbe Museum was the identification of our gallery lighting system as a key element in improving the efficiency and sustainability of the collections environment. Henry was able to determine that the lighting in the main gallery was capable of producing 7650 Watts, substantially more than the use of the space requires, leading to a high, and unnecessary, level of electricity consumption. Because of the light sensitivity of the majority of the Abbe Museum's collections, the lighting system in the main gallery is generally dimmed to between 30% and 40% of its capacity, which is highly inefficient and creates a color shift in the space, which detracts from the exhibits. Furthermore, the operation of this halogen track lighting system adds a noticeable heat load to the space, a load that the HVAC system must then work to overcome.

It is particularly interesting to note that at the time of this final report we are in the process of implementing a number of the steps proposed in the *Environmental Improvements Report*, which has further highlighted the effect of the gallery lighting on the climate control system. Abbe staff had long been concerned that the steam humidification system was adding additional heat to the collection spaces, requiring operation of the chiller to cool these spaces even during the winter months. Henry was skeptical of this theory, and has recommended staying with steam humidification, rather than switching to an ultrasonic system. This conclusion appears to be supported by current monitoring data. Currently, the system is set so that the chilled water system will not operate when outdoor temperatures are below 50˚F, so the systems changes in temperature are only effected by passive building cooling, building heating, humidification, and lighting. During the winter months, the museum is only open to the public three days a week, so the gallery lighting is only on for prolonged periods of time those three days. Current data logger data is showing a notable increase in temperature for at least two of the collections spaces when the lighting is on in the main gallery, rather than temperature increases caused by the operation of the steam humidification system.

Recommended actions to address the lighting/electrical system include a series of steps to reduce consumption and heat load, and improve the performance of the lighting system. The Environmental Improvement Report recommends replacing the 50W lamps in the gallery lighting with 20W or 35W lamps, piloting the replacement of halogen fixtures with LED fixtures in the smaller Community Gallery, and finally redesigning the Main Gallery lighting system, potentially replacing with LED lighting. Initial steps have been taken to try LED lamps in the Community Gallery fixtures, and an electrician and a lighting designer with museum lighting experience have been brought in to assess the Main Gallery lighting. Based on this assessment, the decision has been made to hold off on replacing all of the lamps in the Main Gallery with new lower-wattage lamps, instead applying for an NEH implementation grant to replace the halogen track lighting system throughout the museum's galleries. There are several reasons for this. First, the current lighting system in the museum's galleries is very difficult to work with, and replacing all of the lamps would be labor-intensive and likely lead to the failure of a number of the current fixtures, which are fragile and irreplaceable due to their age. In consultation with the electrician and lighting designer, it was determined that the current track lighting system is residential grade, not commercial grade, and not standard museum gallery lighting. This might explain why whenever the lighting has to be moved for a new exhibit, or when the lamps are changed, several of the fixtures stop working. Also, the manufacturer stopped producing this particular system shortly after it was installed, and replacement fixtures are no longer available. At this time, we have lost so many fixtures that we are not able to adequately light all exhibits, and additional physical work on the current system would likely lead to a serious lighting deficit in our main gallery space. It was also determined that the cost to purchase LED lamps for the current system would be quite high, would only be a temporary solution, and therefore not a wise investment towards long-term sustainability. Current and ongoing research on LED lighting in museums will be taken under careful consideration in carrying out the re-design and replacement of the gallery lighting system.

Passive Measures for environmental stability and reduced demand

The majority of the steps to incorporate passive measures to improve both conditions for collections and to increase the efficiency of building systems involve simple changes in staff behavior and the use of exhibit cases or other containerization to buffer collections from fluctuations in temperature and humidity. Doors between collections spaces and non-collections spaces are now kept closed at all times, except when people are actively passing through them. In the past, these doors were often propped open for convenience. Other doors will have to be retrofitted so they can be kept closed while still providing adequate means of egress for building occupants.

The use of exhibit cases to buffer objects from fluctuations in temperature and RH while on exhibit is something that is already being done at the Abbe- most objects on exhibit are in closed cases. Evaluation of the effectiveness of various cases in buffering fluctuations is still being assessed, and modifications to case seals and closure systems are being evaluated. Options such as adding buffering material to the compact storage shelving and boxing fragile items in buffering enclosures is also under consideration for collections in storage, especially those objects most vulnerable to changes in temperature and humidity. The bigger challenge is what to do about the largest objects in the Abbe Museum's collection, three full-size birchbark canoes. These canoes were identified by conservator Ronald Harvey as potentially vulnerable objects, and several ideas for casing them while on exhibit, and buffering them while in storage, have been discussed. In the process of evaluating these options, two other factors came into the discussion. One is the visitor experience with these objects, and the other is the cultural importance of birchbark canoes to the Wabanaki, and their involvement in the decision-making process at the Abbe Museum. In both cases, putting the birchbark canoes in a large Plexiglas or glass case could present a barrier to viewing the pieces that detracts from the visitor experience, and removes Wabanaki visitors from these important pieces in a way that, while perhaps better for the object, is not a culturally sustainable practice. This highlighted the need for the Abbe, as a non-tribal Native American museum, to take cultural values and sovereignty into careful consideration in all aspects of museum operation, including care of collections.

Additional recommendations were also made to reduce heat loss and gain in spaces with limited collections use, but still draw on the building systems and reduce efficiency. Some of these recommendations have been completed, while others are ongoing.

HVAC System Improvements

The final set of recommendations look at improvements that can be made to the current mechanical and controls systems to improve efficiency and reduce energy consumption, without reducing the level of control for temperature and humidity. These recommendations are fairly technical, and are described in detail in the *Environmental Improvements Report* (Appendix A). They address virtually all aspects of the HVAC system- air handlers, sensors and controls, humidifier, heat recovery units, dehumidification and cooling. Some recommendations involve modification of existing equipment, some require adding localized equipment for specific spaces, and some are simply a matter of changing set points and updating sensors.

The most encouraging aspects of these recommendations are that they do not involve large-scale replacements of the various elements of the mechanical system, other than long-term replacements made necessary by aging equipment, both to be proactive to prevent massive failures (which we know create unacceptable fluctuations in temperature and humidity), and to take advantage of new technologies that improve both performance and efficiency. We do not have to tear apart our mechanical room and invest millions in new equipment, which was certainly a result we feared.

Several of these recommendations are currently underway, while others are in the planning stages, and will depend on the success of grant applications and targeted fundraising. We have found that in most cases, some experimentation has been required, and we have worked back and forth with Michael Henry and our service provider to achieve the desired results and select the best equipment for the application. We have completed a replacement of the HVAC controls system, transitioning to a very user-friendly, web-based program. This new program is easier to understand, provides clearer diagnostic tools, and provides remote access to the system for faster and more appropriate responses to problems. It replaced a DOS-based controls system that used HyperTerminal, and was the opposite of user-friendly.

Accomplishments

In addition to the detailed results and recommendations presented above, several other accomplishments are worth noting.

Perhaps the most important accomplishment is that through the inclusive evaluation process used in this project, Abbe Museum staff gained a much better understanding of our HVAC and lighting systems. We are more familiar with the standards that apply, how the various systems work, what they can and cannot accomplish, and how to trouble-shoot more effectively. The inclusion of the engineer from our service provider, David Clay, throughout the process, has improved communication in both directions, and both the museum and the service provider better understand the needs of the other. We have been able to begin implementing the recommendations, including some aspects that have required experimentation and adaptation, in ways that are clearly understood and are already leading to positive results.

We are also beginning to see reduced consumption resulting from implementation of the recommendations: heating oil consumption is down 20% and electricity use is down 10%. This makes us very optimistic that we will continue to see even greater improvements.

As a bonus, the museum was able to use unexpended funds resulting from planned costs being less than expected, to send project director Julia Clark to a 3-day workshop presented by the Image Permanence Institute, Sustainable Preservation Practices for Managing Storage Environments. This workshop, and the publication that accompanies it, added even more to our understanding of how temperature and humidity can (and cannot) be controlled, how systems for this control work, and how they can be made to work more efficiently and sustainably. It also provided detailed information on the current research in collections care environments, providing a framework to better identify the needs of our collection in the context of sustainability.

Finally, one of the most exciting results of this planning and evaluation project has been the success in fundraising that has resulted, and how far this has allowed us to move towards our goals. Based largely on the *Environmental Improvements Report* (Appendix A), the Abbe Museum developed our Greening the Abbe initiative and campaign beginning in 2012 (see Appendix D for material). The Greening initiative includes implementation of the strategies and actions from the report, along with an institution-wide process of improving sustainability. This includes everything from replacing incandescent lighting with CFL or LED lighting, to local sourcing of material for a variety of museum uses, to the use of recycled or recyclable materials throughout the museum, along with the actions to improve our building systems. The Greening campaign was officially launched at the Abbe's annual Gathering Gala, our largest fundraising event. A paddle raise was carried out by the auctioneer, in which donors gave at several different levels specifically in support of the Greening the Abbe initiative. In a matter of minutes, the museum raised $31,500! We were literally jumping up and down with excitement. This was an effort our supporters clearly thought was worthwhile, and the results of the grant-funded project were essential to making the case. With the funds from the paddle raise, and ongoing donations from our supporters, we are well into the implementation process. We fully expect continued success in raising funds from private donors, and with success in grant applications for additional aspects of implementation, the Abbe Museum will be able to make great strides towards sustainability.

Audiences

The Abbe Museum serves multiple audiences and communities through programs, educational outreach and in-reach, and partnerships with the four Maine tribes, Acadia National Park, and other regional and state-wide organizations. The locations in and near Acadia National Park, draws international visitation, as well as visitors from across the country during five months out of each year when the Park is open. In the off season, the Museum serves communities in Maine, primarily in Hancock County, but also from Washington, Penobscot, and Waldo Counties as well. The Museum has a close relationship with the four tribes in Maine, the Passamaquoddy, Penobscot, Micmac, and Maliseet, collectively known as the Wabanaki, and serves these rural communities through partnerships and programs.

Evaluation

Evaluation of this project has been informal. Discussions among staff and other project participants have taken place, and as the implementation of recommendations moves forward, we will be able to determine if the results are effective in the longer term. Another informal measure of the accomplishments of this project has been the success in fundraising from individual donors to support the implementation, in particular through the Greening of the Abbe campaign.

Continuation of the Project

Discussed above are the various ways this project is continuing. The implementation of the recommendations presented in the *Environmental Improvements Report* is well underway. Some of the recommended actions have been completed, some are in the process of being completed, and others are in the planning stage and are to varying extents funding-dependent. Appendix B presents the table of Recommended Environmental Management Improvements with information on the status of each recommendation.

Long Term Impact

The long-term impact of this project will be seen in improved sustainability in building systems operations along with the long-term maintenance of appropriate conditions for the care of the Abbe Museum's collections. Sustainability will be reflected in both cost savings and a reduction of the environmental impact of our operations. It is also important that, as a non-tribal Native American museum, we operate in ways that are consistent with the sovereignty and cultural values of the Wabanaki communities we work with and represent. Sustainability, respect for the environment, and respectful care of our collections are all consistent with this approach.

We will be conducting long-term monitoring of temperature and humidity in collections spaces, as well as tracking energy consumption to assess the long-term impact of the project.

Grant Products

The primary grant product for the internal use of the Abbe Museum has been the *Environmental Improvements Report* prepared by Michael Henry and Ronald Harvey. This document will serve as our blueprint for implementing sustainability of the Abbe Museum's collections environment. It has also provided key material to support successful fundraising to implement the recommendations.

In September 2011, project director Julia Clark participated in a panel presentation at the American Association for State and Local History annual conference about the Sustaining Cultural Heritage Collections grant program. Alongside presenters from the NEH and participants in other grant-funded projects, Clark shared with the attendees the process, preliminary results, and thoughts about the program as a whole. A copy of this presentation in attached as Appendix C.

The Greening the Abbe initiative and fundraising campaign has been in many ways an outgrowth of this project. More about the Greening the Abbe can be found on the museum’s website at http://abbemuseum.org/support/greening.html and examples of print material created for the campaign are included in Appendix D.

Appendices

A. *Environmental Improvements Report*
B. Recommended Environmental Improvements table with status updates
C. The Abbe Museum’s Sustaining Cultural Heritage Collections Planning Grant, panel presentation, AASLH Annual Meeting, 2011
D. Greening the Abbe campaign material
E. Abbe Museum blog post about the project

Appendix A

Environmental Improvements Report

23 January 2012

Julia Clark
Curator of Collections
Abbe Museum
P.O. Box 286
Bar Harbor, Maine 04609

Subject: **Environmental Improvements Report**
Abbe Museum
Bar Harbor, Maine

Dear Ms. Clark:

Watson & Henry Associates (W&HA), and the Abbe Museum's collections conservation consultant, Ronald Harvey of Tuckerbrook Conservation (TC), are pleased to submit our *Environmental Improvements Report* for the Abbe Museum, Bar Harbor, Maine.

This report presents the results of the joint review of the Abbe Museum building, systems and collections as funded by the grant from the National Endowment for the Humanities under the Sustaining Cultural Heritage Collections program, including the following major tasks to be performed by Watson & Henry Associates:

- Review and analysis of environmental monitoring data;
- Site visit on 19-21 April 2011 for observation of building, environmental and lighting systems, and collections, as well as interviews with Abbe Museum staff, the museum design architect, and the engineer responsible for maintenance of the environmental management control system;
- Facilitation of a collaborative and participatory workshop on 21 April 2011 to: establish objectives for improving interior environmental management at the museum; identify possible realistic and achievable strategies for meeting the objectives; and evaluate and select recommended improvements for meeting the objectives;
- Summarization of the results of the above tasks in a report.

This *Environmental Improvements Report* is the work product of the project, and consists of:

- Project Background;
- Collections Spaces, Systems and Energy Consumption at the Abbe Museum;
- Collection Vulnerabilities at the Abbe Museum;
- Analysis of Environmental Monitoring Data for Collections Spaces;
- Recommended Environmental Improvements;
- Summary
- Appendix A: Tables of Seasonal Environmental Performance of Selected Spaces, including Trend Charts;
- Appendix B: Recommended Environmental Management Improvements;
- Appendix C: Observations and Recommendations of Collections Conservation Consultant;
- Appendix D: Architectural Floor Plans (for spatial reference);
- Appendix E: *Energy Star* Statement of Performance.

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PROJECT BACKGROUND

As a collecting institution, the Abbe Museum focuses on Maine's four Native American tribes: the Penobscot, Passamaquoddy, Micmac and Maliseet, collectively known as the Wabanaki. Operating from two public facilities, the mission of the Abbe Museum is *to inspire new learning about the Wabanaki Nations with every visit.* The Museum's collections, exhibitions, and programs focus on Native American traditions in Maine and explore the broader Native American experience, past and present.

The Museum's collections stand apart from similar collections in the state and region because of its broad time range (12,000 years ago to the present) and the quality of contextual information about the collection. The Abbe Museum holds the largest collection of Maine Indian baskets in a public collection. The Museum's collections management policy and collecting plan limit its permanent collection to Wabanaki-related artifacts and archives, while allowing flexibility in exhibitions and programs to explore a broader range of Native American cultures and issues.

The original 1928 museum facility is a small trailside museum located in Acadia National Park (one of only two trailside museums remaining in the National Parks). A second facility, opened in 2001, is located in downtown Bar Harbor and holds larger exhibition spaces, collections storage, programming spaces, and staff offices. The Abbe Museum's operating budget for 2011 was approximately $700,000 which supports six full-time staff, and several part-time or seasonal paid visitor services staff (the number varies from year to year). In 2009, the Museum managed over 25 volunteers who committed substantial amounts of time to the Abbe. The Museum annually welcomes 25,000 visitors and students, primarily in spring, summer and autumn.

In 2009, the Abbe Museum submitted an application for an environmental improvements planning project grant to the NEH Sustaining Cultural Heritage Collections and was awarded a grant in 2010. In 2010, the Abbe Museum contracted with Watson & Henry Associates and separately with collections conservation consultant Ronald S. Harvey of Tuckerbrook Conservation to provide an *Environmental Improvements Report* for the collections spaces of the Bar Harbor facility.

To assure continued integrity of this nationally-important cultural resource, the present project has been informed by the following guidelines:

- Secretary of Interior's *Standards for the Treatment of Historic Properties 1995* (for the original building);
- *New Orleans Charter for the Joint Preservation of Historic Structures and Artifacts* (for the original building);
- The American Institute for Conservation for Historic and Artistic Works *Code of Ethics*;
- *Suggested Protocol for Diagnostic Monitoring in Museums*, by Michael C. Henry, PE, AIA, for the Getty Conservation Institute, May 1999;
- 2007 American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) *Applications Handbook, Chapter 21: Museums, Libraries and Archives*.

COLLECTIONS SPACES, SYSTEMS AND ENERGY CONSUMPTION AT THE ABBE MUSEUM

The Building

The Bar Harbor facility of the Abbe Museum consists of an early 20th-century two-story, wood-framed structure set on a stone foundation and crawlspace with a large two-and-one-half-story, wood-framed purpose-built museum addition constructed in 2001 (Refer to Appendix D for floor plans). The museum addition contains approximately 6550 square feet on the finished basement story and first story and approximately 2655 square feet on the third story. The earlier portion of the building encloses approximately 2200 square feet on each story. According to the architect, the entire facility encloses 15668 square feet.

The permanent collections are contained in the following spaces (indicated on the architectural floor plans in Appendix D):

- Archaeology Research Laboratory [011]: a basement story space (~560 square feet) accessed from the public basement corridor [002] through a secure vestibule. Room [011] is occupied as an office and collections-care work space and provides secure access to Collections Storage [012]. Room [011] has one exterior subgrade concrete wall and three interior wood-framed partitions; according to the as-built drawings, the interior partition between [011] and [012] contains a vapor retarder, but the interior partitions separating [011] from [002] and [018] lack vapor retarders;
- Collections Storage [012]: a basement story space (~1240 square feet) accessed from Room [011]. Room [012] is used for collections storage on fixed and mobile storage furniture. Room [018] has two exterior subgrade concrete walls and two interior wood-framed partitions; according to the as-built drawings, both of the interior partitions have vapor retarders;
- Main Gallery [117/118]: a voluminous first story space (~2800 square feet) accessed at two points from Exhibit Hall [109], which also functions as a public corridor. Room [117/118] is enclosed by wood-framed, windowless exterior walls on the north, west, south and east (partial) sides and by a wood-framed interior partition along the common wall with Exhibit Hall [109]. Room [117/118] is open to the underside of the single ridge, two-slope gable roof above, resulting in a ceiling height of ~28 feet at the ridge and ~10 feet at the side walls. The west slope is exposed to the exterior and the east slope abuts attic. According to the as-built drawings, all interior and exterior wall assemblies and roof assemblies enclosing the Main Gallery [117/118] include vapor retarders. In the Main Gallery, lighting tracks are suspended at ~15 feet above the floor and HVAC ducts are suspended at ~21 feet above the floor.

The Environmental Management System

Environmental management for the permanent collections spaces at the Abbe Museum is provided by the following:

- A single constant volume Air Handling Unit (AHU-1, rated at 3775 CFM), and fitted with filters, chilled water cooling coil, steam humidifier and separate, zone-controlled hot water reheat coils for the three spaces served. Hot and chilled water to each of the coils is controlled by modulating valves.
- Hot water supplied by a pair of fuel-oil-fired boilers;
- Chilled water supplied by a single air-cooled chiller unit;
- Humidifier steam supplied by a single electric-powered steam humidifier;
- Space conditions reported by separate temperature sensors and humidity sensors in each of the three zones;
- System control by a DOS-based, non-Web-accessible, computer terminal located in A-V Room [213];
- Supply air delivered to spaces via sheet metal ductwork to supply grilles in the ceiling or near the ceiling;
- Return air drawn from return grilles in the floor or near the floor, and delivered to the AHU via sheet metal ductwork;
- Outside air provided through an energy recovery unit (ERV-1, rated at 930 CFM), fitted with a hot water preheat coil and enthalpy wheel.

The Exhibit Lighting System

Exhibit lighting in the Main Gallery [117/118] is provided by 133 halogen lights (50 Watts each), mounted on tracks ~15 feet above the floor, with lighting levels controlled by a theatrical-quality lighting control system with preset dimming schemes. The total lighting available is 7650 Watts for 2800 square feet of gallery floor area, or 2.7 Watts per square foot; the available lighting intensity is so great that the system is typically dimmed to 30%, resulting in spectral shift in the light from the heavily dimmed lamps.

Energy Consumption at the Abbe Museum

David Clay, PE, of Mechanical Services, Inc., prepared an Energy Star *Statement of Energy Performance* for the Abbe Museum (Appendix E) and found that overall energy consumption is somewhat higher than average for commercial uses in the region. Details of the Energy Star program can be found at http://www.energystar.gov/ .

Mr. Clay identified that reducing site energy usage per square foot to the regional average would save approximately $10,000 per year. Further reductions and savings, below the average usage per square foot, are possible.

COLLECTION VULNERABILITES AT THE ABBE MUSEUM

Collections conservator Ronald S. Harvey describes the collections and their environmental vulnerabilities as follows.

The collections housed in the Abbe Museum building located in downtown Bar Harbor are comprised of both inorganic and organic collections. The collections reflect the cultural, historical and artistic expression of the Wabanaki people.

The primary collections areas, the storage room in the lower level of the building and the large exhibit gallery on the first floor, house the majority of the collections. The organic collections are most at risk when there are radical swings in relative humidity and temperature resulting in these fragile collections attempting to adjust to their environment. The basketry collection is prone to damage as these collections are made from manipulated natural material, such as wood from ash trees, which has been delaminated, soaked and woven to form a variety of baskets. The thin sections of split ash expose surfaces of the wood to the environment and are ever striving to equilibrate with the ambient relative humidity. Composite collections made from birch bark and wood elements such as canoes are under some level of stress due to construction techniques and are also susceptible to tension and compression as a result of abrupt and radical changes in ambient relative humidity in the museum environment. Collections comprised of hide or skins are prone to damage from high or low interior relative humidity as these objects attempt to equilibrate to the ambient relative humidity.

Archival materials in the form of rare books and documents are also at risk of micro-organism activity in the event of sustained high relative humidity.

In the Main Gallery [117/118], nearly all objects are exhibited in closed acrylic vitrines; the notable exceptions are very large objects such as a canoe.

ANALYSIS OF ENVIRONMENTAL MONITORING DATA FOR COLLECTIONS SPACES

Environmental monitoring utilized dataloggers from Onset Computer Corporation selected and installed by the Abbe Museum staff in April 2003.

For this report, monitoring data provided by the museum for the period from September 2009 through August 2010 were analyzed. The monitoring data had been taken from the following locations:

- Archaeology Research Laboratory [011]: HOBO H08 temperature and relative humidity logger;
- Collections Storage [012]: HOBO H14 temperature and relative humidity logger;
- Collections Storage [012]: HOBO H08 temperature and relative humidity logger;
- Main Gallery [117/118]: HOBO H14 temperature and relative humidity logger;
- Main Gallery [117/118]: HOBO H08 temperature and relative humidity logger.

Statistical analysis of the data was performed for Watson & Henry Associates by subconsultant Wendy Jessup and Associates, Inc., using analytical and formatting procedures previously developed by the two firms. Watson & Henry Associates then analyzed the statistical environmental data and classified the interior environmental performance according to Class of Control, using Table 3 of ASHRAE Chapter 21.

Class of Control of Collections Spaces
The extent to which temperature and relative humidity are controlled within a space can be classified using Table 3 in Chapter 21, *Museums, Galleries, Archives and Libraries* of the 2007 *Applications Handbook* of the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE). For ease of reference, the table has been reformatted below:

ASHRAE Control Class Criteria		AA	A Float RH	A Fixed RH	B	C	D
Dry Bulb Temp °F	Average (note 1)	70	70	70	70	70	70
	Max (annual)	83	83	83	86	86	No Limit
	Min (annual)	57	48	48	48	No Limit	No Limit
	Max Seasonal Setpoint Shift	↑9 ↓9	↑9 ↓18	↑9 ↓18	↑18 ↓18	No Limit	No Limit
	"Short Fluctuations" Max 24 hr range	±4 (≤8)	±4 (≤8)	±4 (≤8)	±9 (≤18)	No Limit	No Limit
Relative Humidity %	Average (note 1)	50	50	50	50	50	50
	Max (annual)	55	65	60	70	75	75
	Min (annual)	45	35	40	30	25	No Limit
	Max Seasonal Setpoint Shift	None	↑10 ↓10	None	↑10 ↓10	No Limit	No Limit
	"Short Fluctuations" Max 24 hr range	±5 ≤10	±5 ≤10	±10 ≤20	±10 ≤20	No Limit	No Limit

The Class of Control that can be achieved in a building used for collections is a function of two primary, and equally important, considerations:

- The vulnerability or fragility of the collections with respect to environmental factors;
- The ability of the building envelope and mechanical systems to maintain the desired interior temperature and relative humidity in the context of the exterior climate.

These two considerations must be balanced. For example, tight environmental control for highly vulnerable collections cannot be achieved in a building with an unsubstantial building envelope.

For the first consideration, the ranking of environmental risks to collections associated with each class of control is as follows:

- Class AA: lowest risk
- Class A (Float RH): very low risk
- Class A (Fixed RH): very low risk
- Class B: moderate risk
- Class C: high risk
- Class D: highest risk

For the second consideration, the highest class of control that can reasonably be achieved in a given building type in the Zone 6A (Cold-Humid) climate of Maine is as follows:

- Class AA: requires metal wall construction, interior rooms with sealed walls and controlled occupancy;
- Class A (Float RH): requires insulated structures, double glazing, vapor retardant, double doors;
- Class A (Fixed RH): requires insulated structures, double glazing, vapor retardant, double doors;
- Class B: requires heavy masonry or composite walls with plaster. Tight construction, storm windows;
- Class C: requires uninsulated masonry or framed and sided walls, single glazed windows;
- Class D: requires sheathed post and beam structure.

Based on the as-built drawings and observations of the 2001 addition to the Abbe Museum, the building envelopes of the three collections spaces should be able to maintain Class A (Float RH) as a minimum threshold, and could maintain Class AA performance much of the year, when exterior conditions are relatively consistent and not transient between weather systems.

Table 3 of ASHRAE Chapter 21 identifies the conservation consequences of Class A (Float RH) environmental control as: Small risk of mechanical damage to high vulnerability artifacts; no mechanical risk to most artifacts, paintings, photographs, and books. Chemically unstable objects unusable within decades.

Control Class A (Float RH) is therefore the benchmark against which actual environmental management performance at the Abbe Museum may be judged.

Analysis of Environment Management Performance at Abbe Museum

Appendix A contains tables of environmental performance of the three collections spaces at the Abbe Museum. The data are organized by season, and the comments reflect the actual performance with respect to the target threshold Class of Control for the two parameters of interest, temperature and relative humidity.

Based on the analysis presented in the tables, the environmental management performance in the three collections spaces at the Abbe Museum may be summarized as follows:

- **Archaeological Research Laboratory [011]**
  Temperature control is within Class AA limits for maximum and minimum temperatures, seasonal fluctuations except for a high temperature excursion on 12 August 2010. 97% of short term (24 hour) fluctuations fall within Class B limits, and 67% of short term fluctuations fall within Class AA limits.
  Comment: Control of short term temperature fluctuations needs improvement.

  Relative humidity control in winter 2010 and summer 2010 only meet Class D limits for minimum RH, primarily due to a service failure of the humidifier. Except for a humidifier outage in winter 2010 and a high temperature excursion in summer 2010 which depressed RH, 97% of short term (24 hour) RH fluctuations fall within Class B limits, and 67% of short term RH fluctuations fall within Class AA limits.
  Comment: Extreme low relative humidity presents a serious risk of damage to collections without the benefits of the buffering effects of vitrines or housings. Performance with respect to minimum RH must be improved.

- **Collections Storage [012]**
  Temperature control is within Class AA limits for maximum and minimum temperatures, seasonal fluctuations, and short term (24 hour) fluctuations.
  Comment: Temperature stability in Collections Storage is excellent and is largely attributable to high thermal mass, limited occupancy and buffered access to other spaces.

  Relative humidity control in winter 2010 only meets Class D limits for minimum RH, seasonal fluctuation and short term fluctuations, primarily due to a service failure of the humidifier. Otherwise, in autumn, summer and spring, relative humidity control meets Class A (Float RH) limits for maximum and minimum relative humidity, seasonal fluctuations and short term (24 hour) fluctuations.
  Comment: Extreme low relative humidity presents a serious risk of damage to the collections; damage from the identified low RH episodes may have been limited due to the buffering effects of housings for the stored collections. Performance with respect to minimum RH must be improved.

- **Main Gallery [117/118]**
  Temperature control is within Class AA limits for maximum and minimum temperatures, seasonal fluctuations, and short term (24 hour) fluctuations.
  Comment: Temperature stability in the Main Gallery is excellent and is largely attributable to buffered access from other spaces.

Relative humidity control in winter 2010 only meets Class D limits for minimum RH, and Class C for seasonal fluctuation, primarily due to a service failure of the humidifier. In autumn, summer and spring, relative humidity control meets Class A (Float RH) limits for maximum and minimum relative humidity and seasonal fluctuations. In autumn, summer and spring, 97% of short term (24 hour) RH fluctuations fall within Class B limits, and 67% of short term RH fluctuations fall within Class AA limits.

Comment: Extreme low relative humidity presents a serious risk of damage to the collections; damage from the identified low RH episodes may have been limited due to the buffering effects of acrylic vitrines for the exhibited collections. Performance with respect to minimum RH must be improved.

RECOMMENDED ENVIRONMENTAL IMPROVEMENTS

A workshop was convened at the Abbe Museum on 26 May 2011 for the purposes of reviewing the analysis and conclusions of the monitoring program and for determining possible strategies for improving the conservation environment of the collections spaces. Michael C. Henry facilitated the discussion.

The workshop participants included:
- Cinnamon Catlin-Legutko, Chief Executive Officer, Abbe Museum;
- Julia Clark, Curator of Collections; Abbe Museum;
- John Brown, Director of Finanace and Administration, Abbe Museum;
- Jonathan Traficonte, AIA, Schwartz/Silver Architects, Inc., designer of the museum;
- David Clay, PE, Mechanical Services, Inc., service contractor for the museum;
- Ronald S. Harvey, Tuckerbrook Conservation, conservator;
- Michael C. Henry, PE, AIA, collections environmental management consultant.

The results are summarized here in terms of:
- Objectives;
- Strategies.

Objectives:
The objectives for this project were previously identified in the NEH Sustaining Cultural Collections grant application submitted by the Abbe Museum:

> The Abbe Museum's goals for this project are to review the current climate control systems, review and re-identify appropriate standards for exhibition and storage environments, and determine if the system can be re-engineered or altered to meet the new environmental preservation standards as well as implement identified "green" approaches to the building environment. In this regard, the project is aligned with the Museum's strategic goal to *maintain and improve facilities and infrastructure to support essential programs and to promote long-term sustainability*. One of the tactical measures to assist with this goal is to *analyze the existing Abbe Museum climate control systems and examine passive and low-energy alternatives* (items in italics are directly from the strategic plan).

Strategies
In order to achieve the above objectives, the following broad strategies were developed:
- Lighting and electrical improvements for reduced energy consumption;
- Passive measure for interior environmental stability to reduce demand on the environmental management (HVAC) system;
- Environmental management (HVAC) system improvements for improved efficiency and reduced energy consumption (electricity and fuel oil).

Within the above strategies, twenty specific actions were evaluated and recommended, including responsibility, sequence and target dates for completion. The actions range from simple measures that can be implemented immediately, with relatively low cost, to longer-term capital improvements. Several of the actions involve prototypical implementation to allow for evaluation and adjustment for optimization.

It is important to note that the strategies do not involve tightening of the target Class of Control for the collections spaces of the Abbe Museum; on the contrary, implementation of the actions, particularly those which buffer the relative humidity of stored and exhibited collections, will effectively reduce the impact of fluctuations in the space conditions on the vulnerable collections objects. Ultimately, short term fluctuations in relative humidity may be less critical to the collections if vulnerable objects are well-buffered in storage housings or exhibit vitrines.

The recommended improvements and actions are detailed in Appendix B. Specific recommended actions improvements for collections are contained in Appendix C.

SUMMARY

The Abbe Museum benefits in having a purpose-built addition with a building envelope that was designed and constructed specifically for relative humidity control in collections areas. Although the first decade of operation of the HVAC system has reported to have been problematic and frustrating for the museum staff, overall design intent for the system is consistent with what is needed for relative humidity control for collections. The Recommended Environmental Improvements in Appendix B set out the actions need to resolve performance issues, reduce energy consumption and protect the relative humidity-vulnerable collections while retaining the existing elements and infrastructure of the 2001 HVAC system that serve the collections. Furthermore, the Recommended Environmental Improvements also address opportunities for reduced energy consumption for the museum beyond the collections areas.

Watson & Henry Associates and Tuckerbrook Conservation are pleased to have been a part of this important project, thank all of the project participants for their open and enthusiastic collaboration and look forward to advancing the future conservation and stewardship of the collections at the Abbe Museum.

Respectfully,

Michael C. Henry, PE, AIA
NJ PE 25633 NJ RA 11115

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23Dec2011 Environmental Improvements Report Draft.doc

Appendix A

Tables of Seasonal Environmental Performance of Selected Spaces
With Representative Trend Charts for Selected Interior Spaces and the Exterior

	ASHRAE Control Class Criteria	AA	A Float RH	A Fixed RH	B	C	D
Dry Bulb Temp °F	Average (note 1)	70	70	70	70	70	70
	Max (annual)	83	83	83	86	86	No Limit
	Min (annual)	57	48	48	48	No Limit	No Limit
	Max Seasonal Setpoint Shift	↑9 ↓9	↑9 ↓18	↑9 ↓18	↑18 ↓18	No Limit	No Limit
	"Short Fluctuations" Max 24 hr range	±4 (≤8)	±4 (≤8)	±4 (≤8)	±9 (≤18)	No Limit	No Limit
Relative Humidity %	Average (note 1)	50	50	50	50	50	50
	Max (annual)	55	65	60	70	75	75
	Min (annual)	45	35	40	30	25	No Limit
	Max Seasonal Setpoint Shift	None	↑10 ↓10	None	↑10 ↓10	No Limit	No Limit
	"Short Fluctuations" Max 24 hr range	±5 ≤10	±5 ≤10	±10 ≤20	±10 ≤20	No Limit	No Limit

Note:

1. Average conditions are generally accepted as 70 °F, 50 %RH for loans, or the historical average for the permanent collection.
2. For example, 45-55% RH setpoints with 5% allowable drift, would give a total annual range of 40-60% overall which would be Class A, Fixed RH.
3. Reference American Society of Heating, Refrigerating and Air-Conditioning Engineers, *2007 ASHRAE Applications Handbook*, Chapter 21 "Museums, Galleries, Archives and Libraries"
4. Criteria reflect collections conservation priorities, not priorities for human comfort.
5. For the permanent collections spaces in the Abbe Museum, Class A (float RH) is the minimum realistic and achievable target; Class AA may be realistic and achievable for much of the year.
6. In the tables that follow, highlighted data indicate conditions that do not meet or exceed the target minimum parameters for ASHRAE Control Class A (Float RH).

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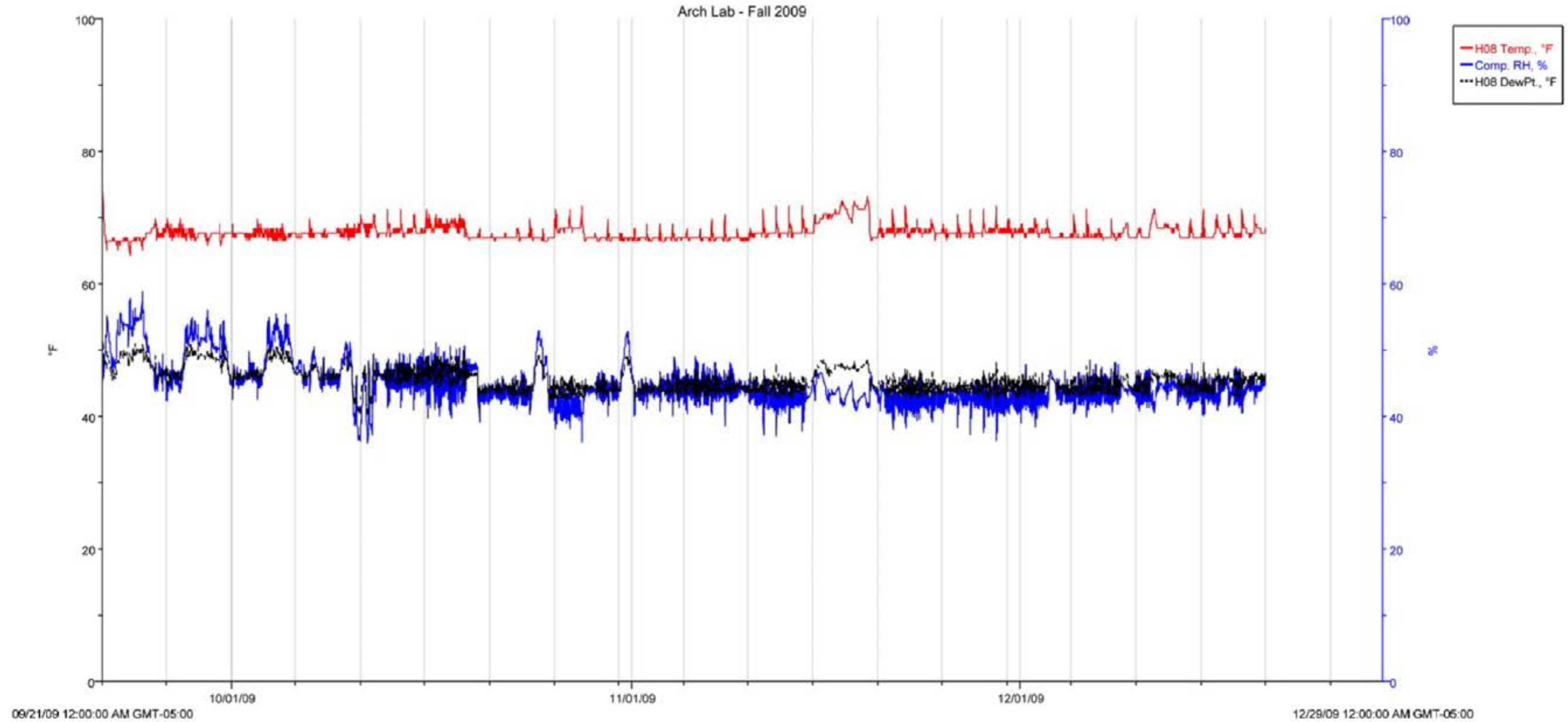
Seasonal Data: Archeological Research Laboratory [011] HOBO H08 (30 minute logging intervals)						
Variable		Autumn 2009	Winter 2010	Spring 2010 (3/21-5/16)	Summer 2010	Analysis & Comments
Dry Bulb Temp °F	Ave	67.7	68.3	67.8	68.2	T limits meet Class AA except for hi T excursion on 8/12.
	Max	74.5	73.2	73.2	94.0	
	Min	64.2	62.9	64.2	60.8	
	Seasonal Range	10.3	10.3	9.0	33.2	Seasonal ΔT within Class AA limits except for hi T excursion on 8/12.
	Max 24 hr range	10.3	8.3	8.3	33.2	66% of 24 hr ΔT (± 1 standard deviation) within Class AA limits except for hi T excursion on 8/12. 97% of 24 hr ΔT (± 2 standard deviation) within Class B limits except for hi T excursion on 8/12.
	Max 24 hr standard deviation	1.9	2.1	2.9	4.5	
Dew Point Temp °F	Ave	45.5	42.2	44.4	47.7	Low DpT event in winter due to humidifier outage 1/7 -1/27.
	Max	52.3	49.6	49.5	58.3	
	Min	39.7	27.8	41.1	38.4	
Relative Humidity %	Ave	44.8	39.7	42.9	48.0	RH limits close to Class A (float) in autumn & spring, but lo RH in Winter and Summer only meet Class D due to humidifier outage and hi T excursion on 8/12. Seasonal ΔRH meets Class A (float) in autumn & spring, but only Class C in Winter and Summer due to humidifier outage & hi T excursion on 8/12.
	Max	58.8	53.5	53.3	67.6	
	Min	35.8	23.4	33.3	23.7	
	Seasonal Range	23.0	30.1	20.0	43.9	
	Max 24 hr range	16.6	30	16.7	33.3	66% of 24 hr ΔRH (± 1 standard deviation) within Class AA limits except for winter humidifier & summer hi T excursion. 97% of 24 hr ΔRH (± 2 standard deviations) within Class B limits except for winter humidifier & summer hi T excursion.
	Max 24 hr standard deviation	4.4	11.1	3.4	6.4	
TWPI (Years)		50.0 (moderate)	55.0 (moderate)	54.0 (moderate)	46 (moderate)	Rate of deterioration of paper-based materials.
Mold Risk Factor		0 (none)	0 (none)	0 (none)	0 (none)	Potential for mold growth in paper-based materials.



Arch Lab - Fall 2009
100
80
60
40
20
0
°F
%
H08 Temp., °F
Comp. RH, %
H08 DewPt., °F
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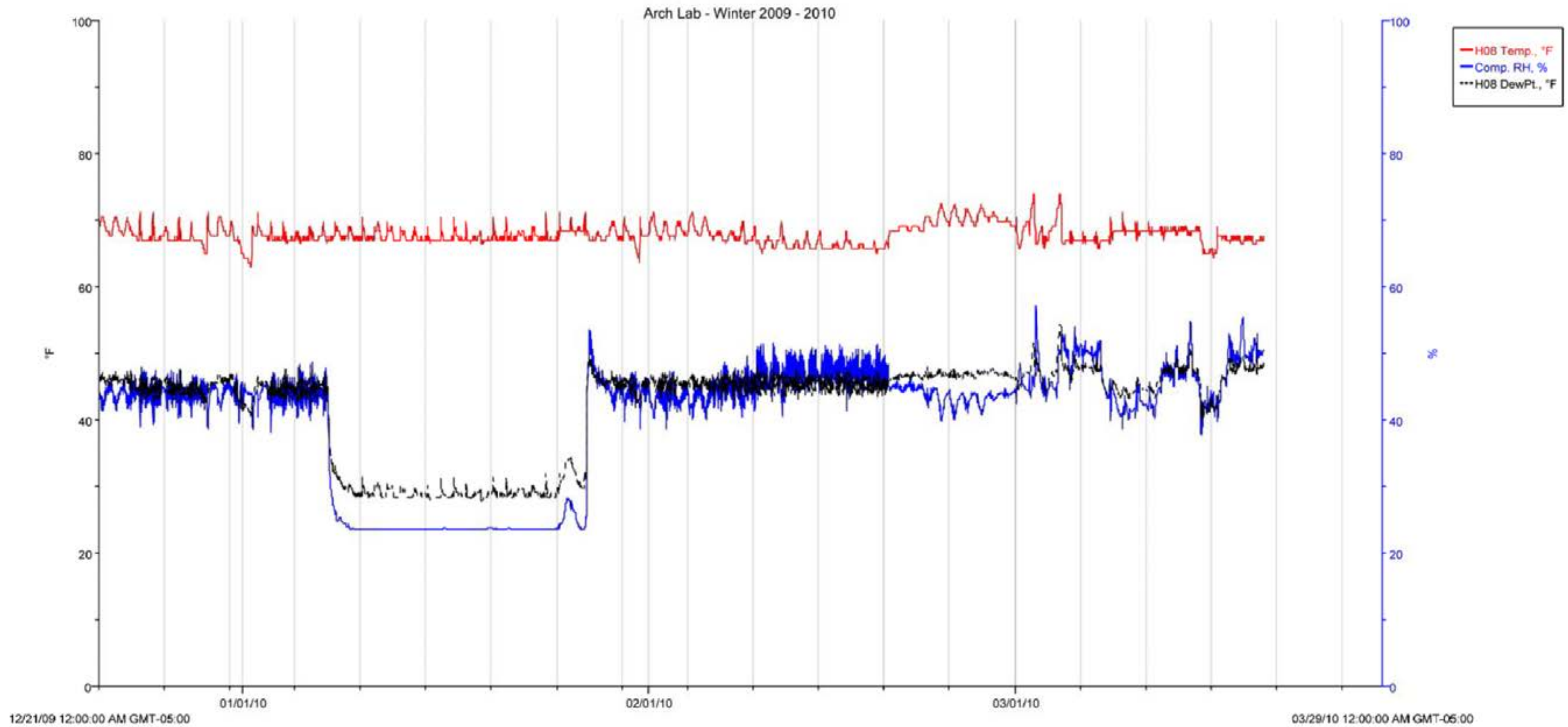
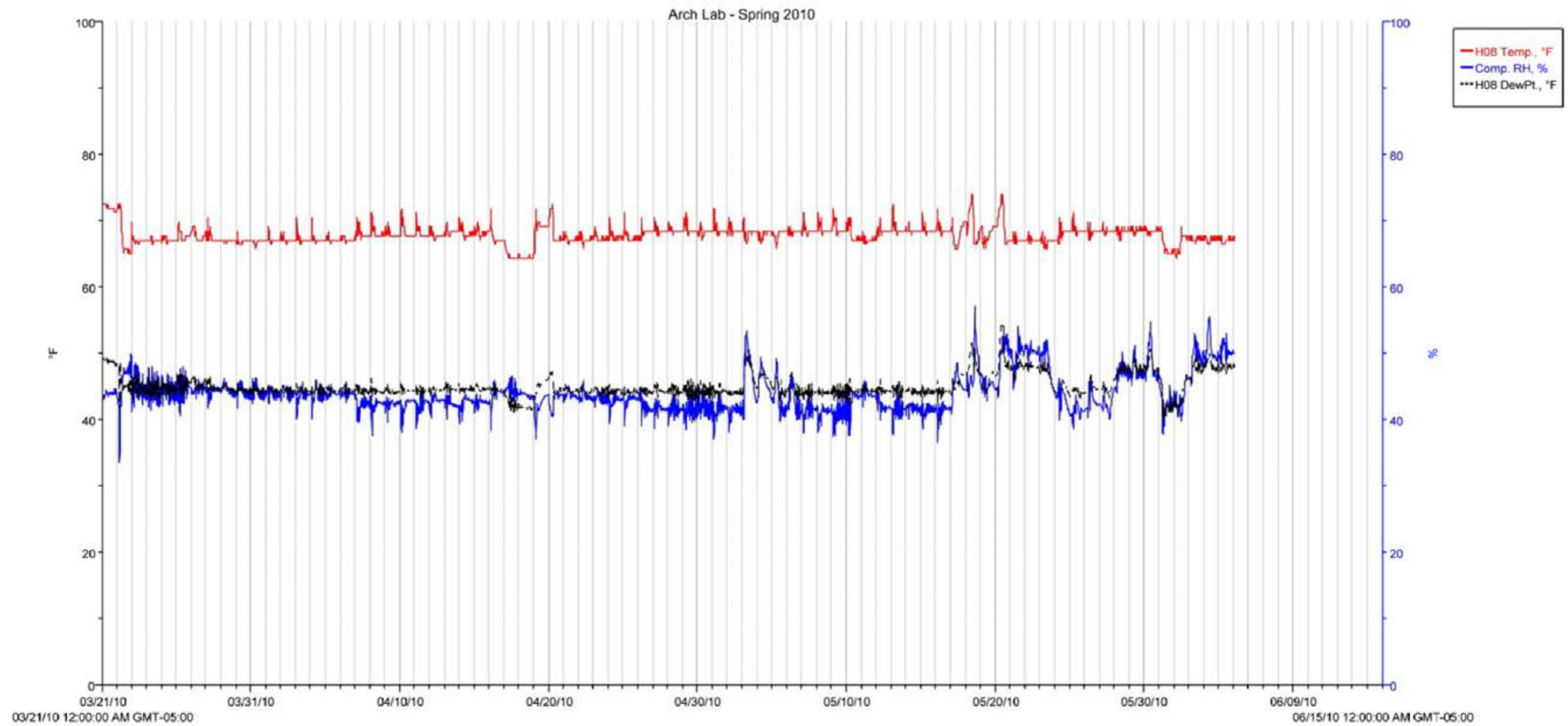
11/01/09
12/01/09
09/21/09 12:00:00 AM GMT-05:00
12/29/09 12:00:00 AM GMT-05:00



Arch Lab - Winter 2009 - 2010
H08 Temp., °F
Comp. RH, %
H08 DewPt., °F
°F
%
100
80
60
40
20
0
01/01/10
02/01/10
03/01/10
12/21/09 12:00:00 AM GMT-05:00
03/29/10 12:00:00 AM GMT-05:00



Arch Lab - Spring 2010
H08 Temp., °F
Comp. RH, %
H08 DewPt., °F
°F
%
03/21/10
03/31/10
04/10/10
04/20/10
04/30/10
05/10/10
05/20/10
05/30/10
06/09/10
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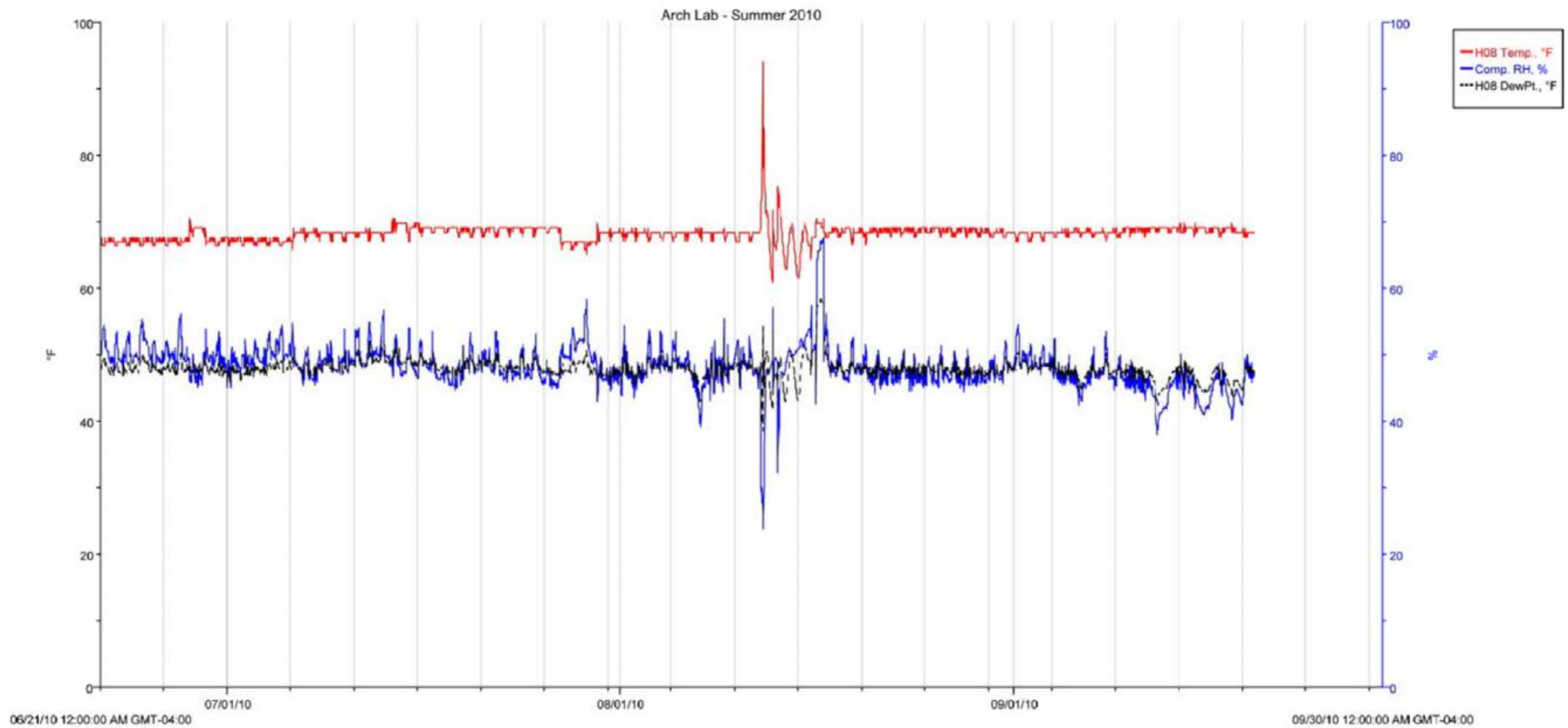
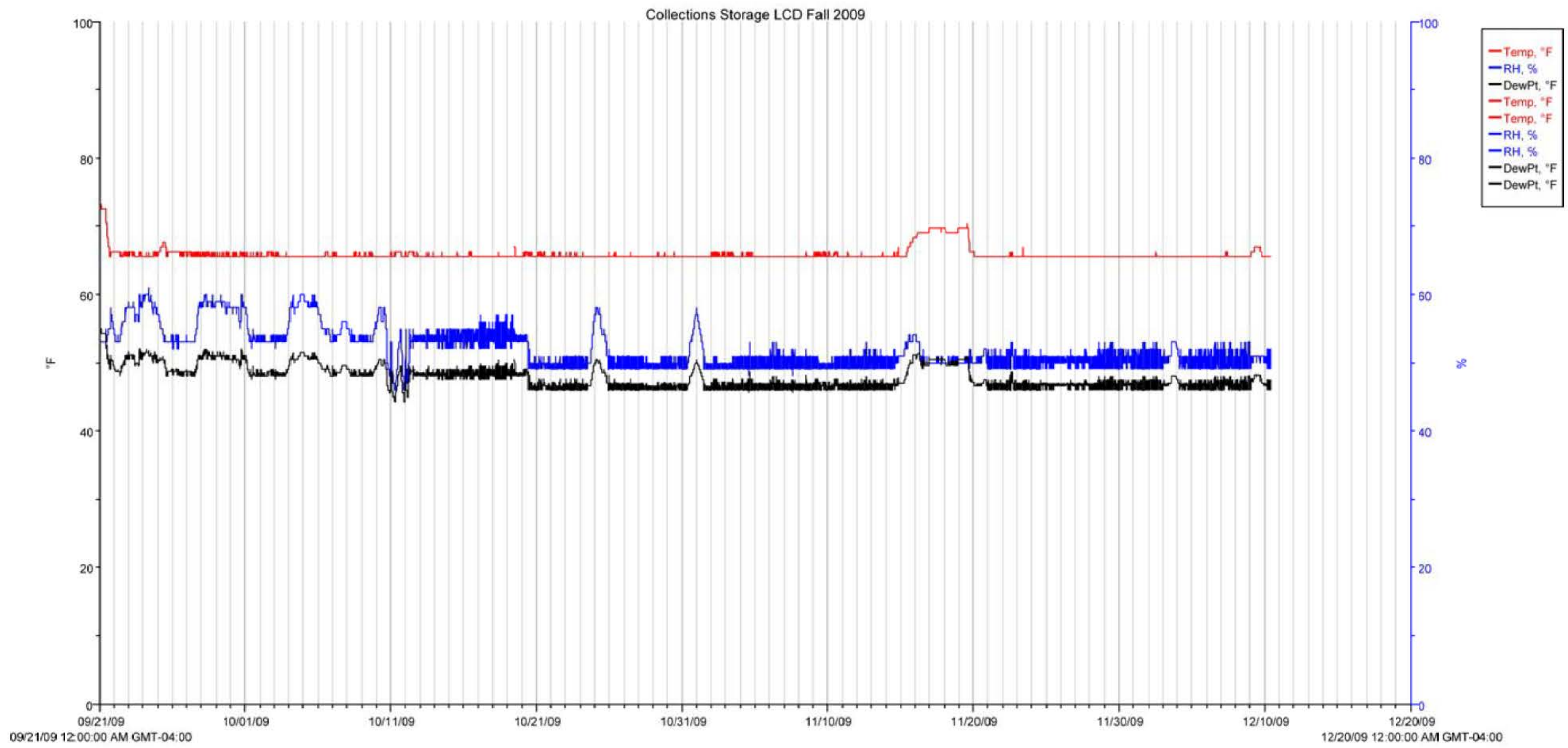


Arch Lab - Summer 2010
H08 Temp., °F
Comp. RH, %
H08 DewPt., °F
°F
%
100
80
60
40
20
0
07/01/10
08/01/10
09/01/10
06/21/10 12:00:00 AM GMT-04:00
09/30/10 12:00:00 AM GMT-04:00

Seasonal Data: Collections Storage [012] HOBO H14 (10 minute logging intervals)						
Variable		Autumn 2009	Winter 2010	Spring 2010 (3/21-5/16)	Summer 2010	Analysis & Comments
Dry Bulb Temp °F	Ave	66.0	66.7	65.8	65.9	T limits meet Class AA.
	Max	73.1	71.8	71.8	67.0	
	Min	65.6	62.9	63.5	65.6	Seasonal ΔT within Class AA limits.
	Seasonal Range	7.5	8.9	8.3	1.4	
	Max 24 hr range	7.6	4.1	4.8	1.4	100% of 24 hr ΔT within Class AA limits. .
	Max 24 hr standard deviation	3.0	1.7	1.9	0.4	
Dew Point Temp °F	Ave	47.8	42.3	46.9	50.3	Low DpT event in winter due to humidifier outage 1/7 -1/27.
	Max	55.0	52.2	52.2	53.4	
	Min	44.2	15.1	43.5	46.6	
Relative Humidity %	Ave	51.9	43.7	50.3	57.0	RH limits within Class A (float) in autumn, spring & summer, but lo RH in Winter only meets Class D due to humidifier outage. Seasonal ΔRH meets Class A (float) in autumn, spring & summer, but only Class C in Winter due to humidifier outage.
	Max	61.0	54.0	58.0	63.0	
	Min	46.0	14.0	41.0	49.0	
	Seasonal Range	15.0	40.0	17.0	14.0	
	Max 24 hr range	10.0	26.0	10.0	7.0	100% of 24 hr ΔRH within Class A (float) in autumn, spring & summer, but 24 hr ΔRH in Winter only meets Class D due to humidifier outage.
	Max 24 hr standard deviation	3.3	11.4	3.2	2.4	
TWPI (Years)		45.0 (moderate)	55.0 (moderate)	49.0 (moderate)	41.0 (moderate)	Rate of deterioration of paper-based materials
Mold Risk Factor		0 (none)	0 (none)	0 (none)	0 (none)	Potential for mold growth in paper-based materials



Collections Storage LCD Fall 2009
Temp, °F
RH, %
DewPt, °F
Temp, °F
Temp, °F
RH, %
RH, %
DewPt, °F
DewPt, °F
°F
%
09/21/09
10/01/09
10/11/09
10/21/09
10/31/09
11/10/09
11/20/09
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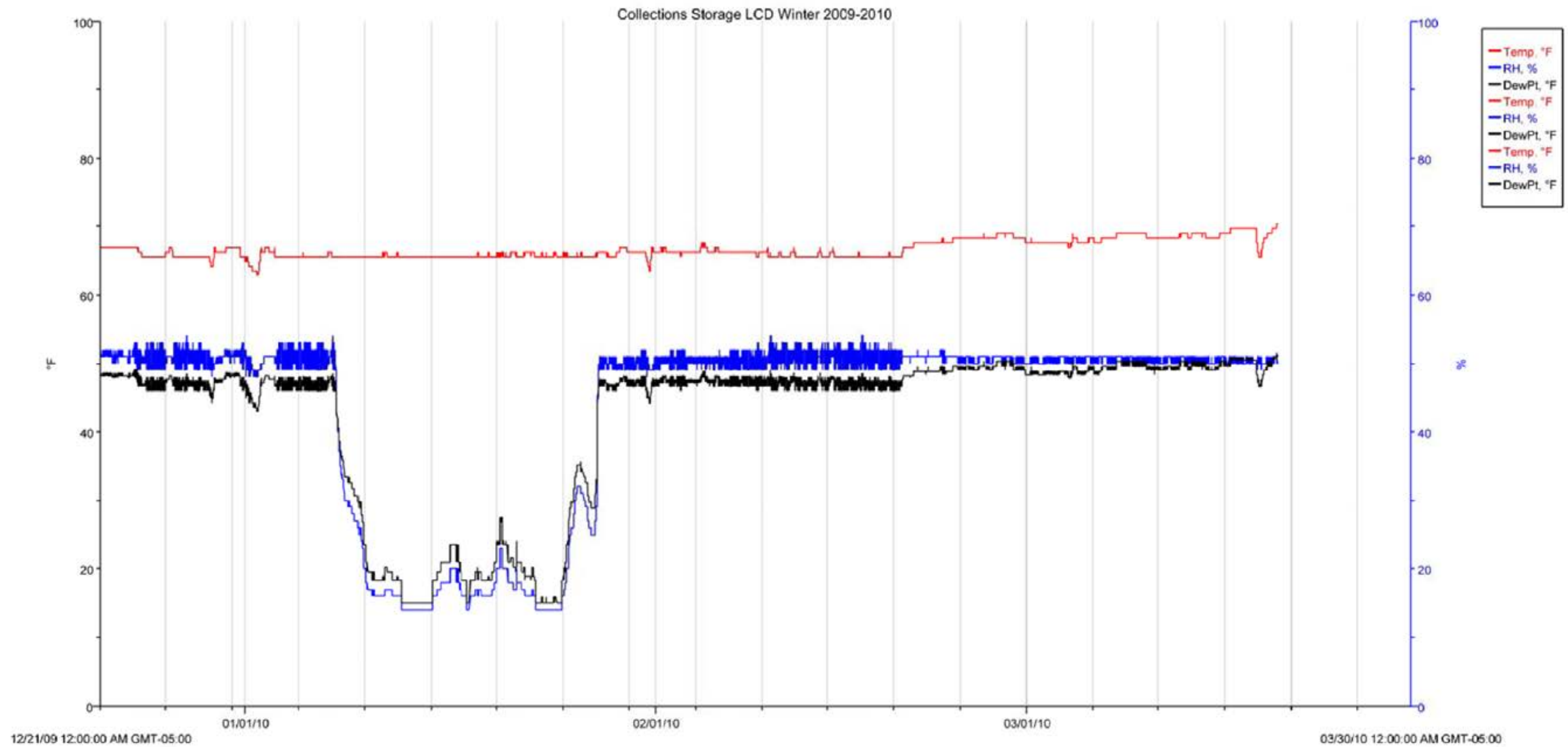
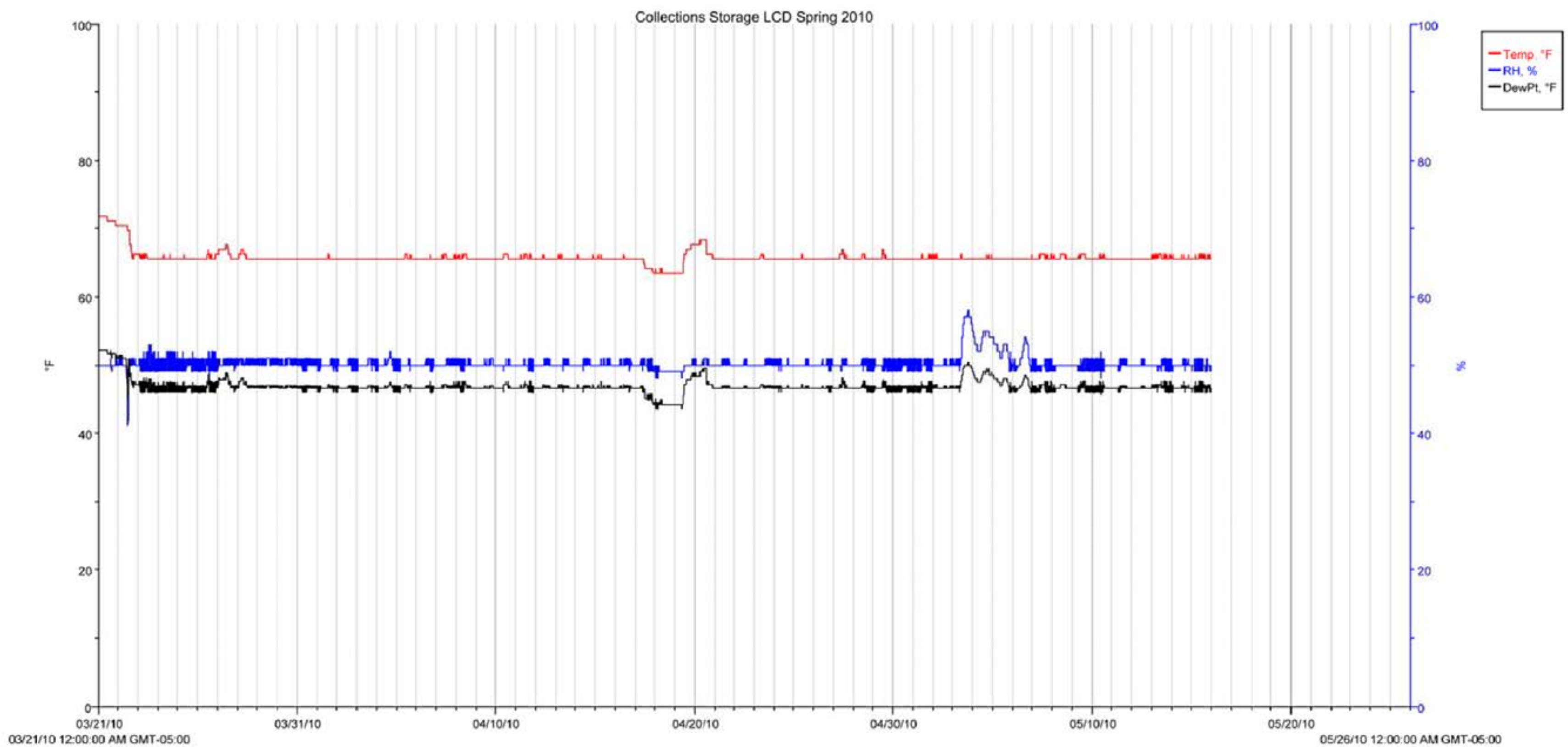

Collections Storage LCD Winter 2009-2010
100
80
60
40
20
0
°F
%
Temp, °F
RH, %
DewPt, °F
Temp, °F
RH, %
DewPt, °F
Temp, °F
RH, %
DewPt, °F
01/01/10
02/01/10
03/01/10
12/21/09 12:00:00 AM GMT-05:00
03/30/10 12:00:00 AM GMT-05:00


Collections Storage LCD Spring 2010
100
80
60
40
20
0
°F
%
Temp, °F
RH, %
DewPt, °F
03/21/10
03/31/10
04/10/10
04/20/10
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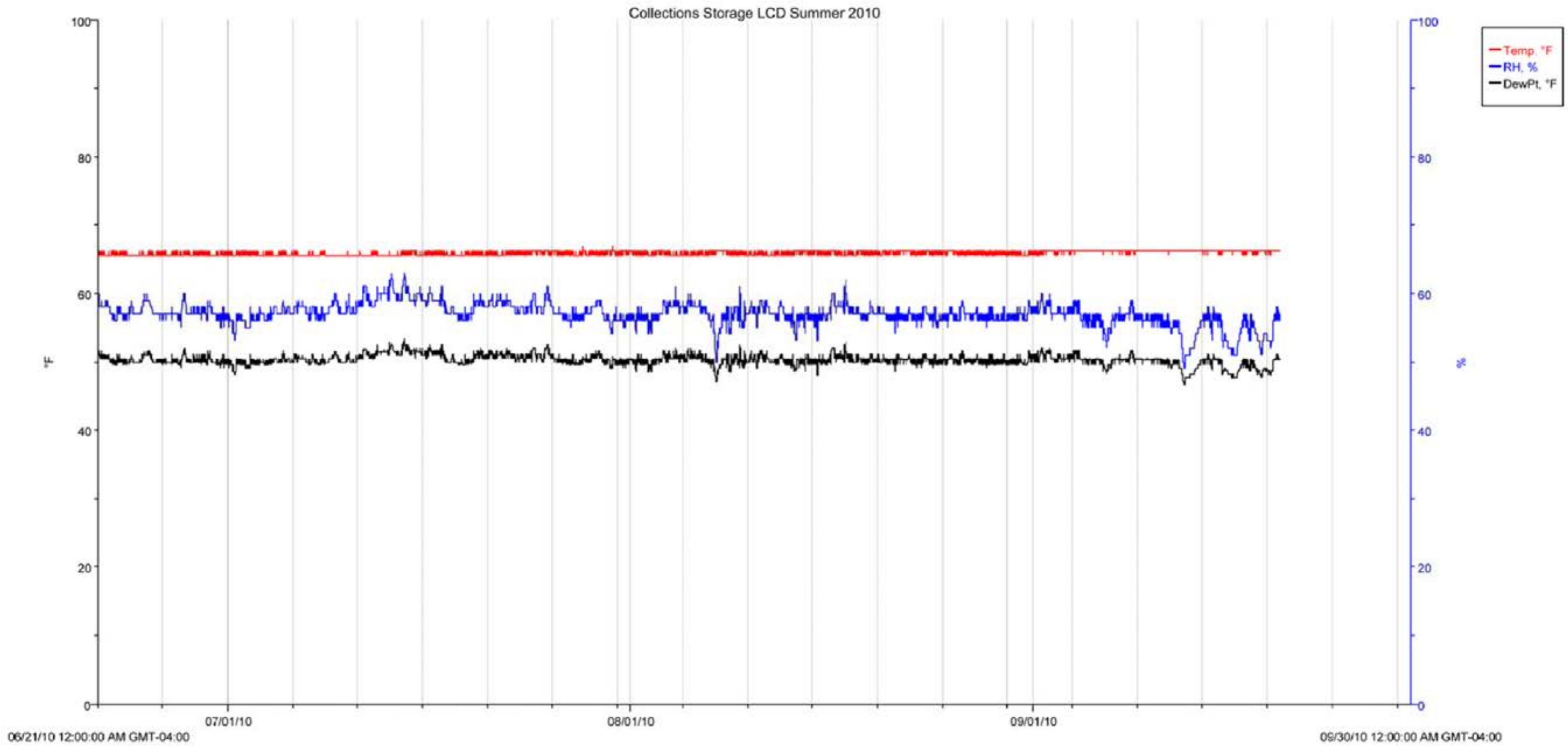
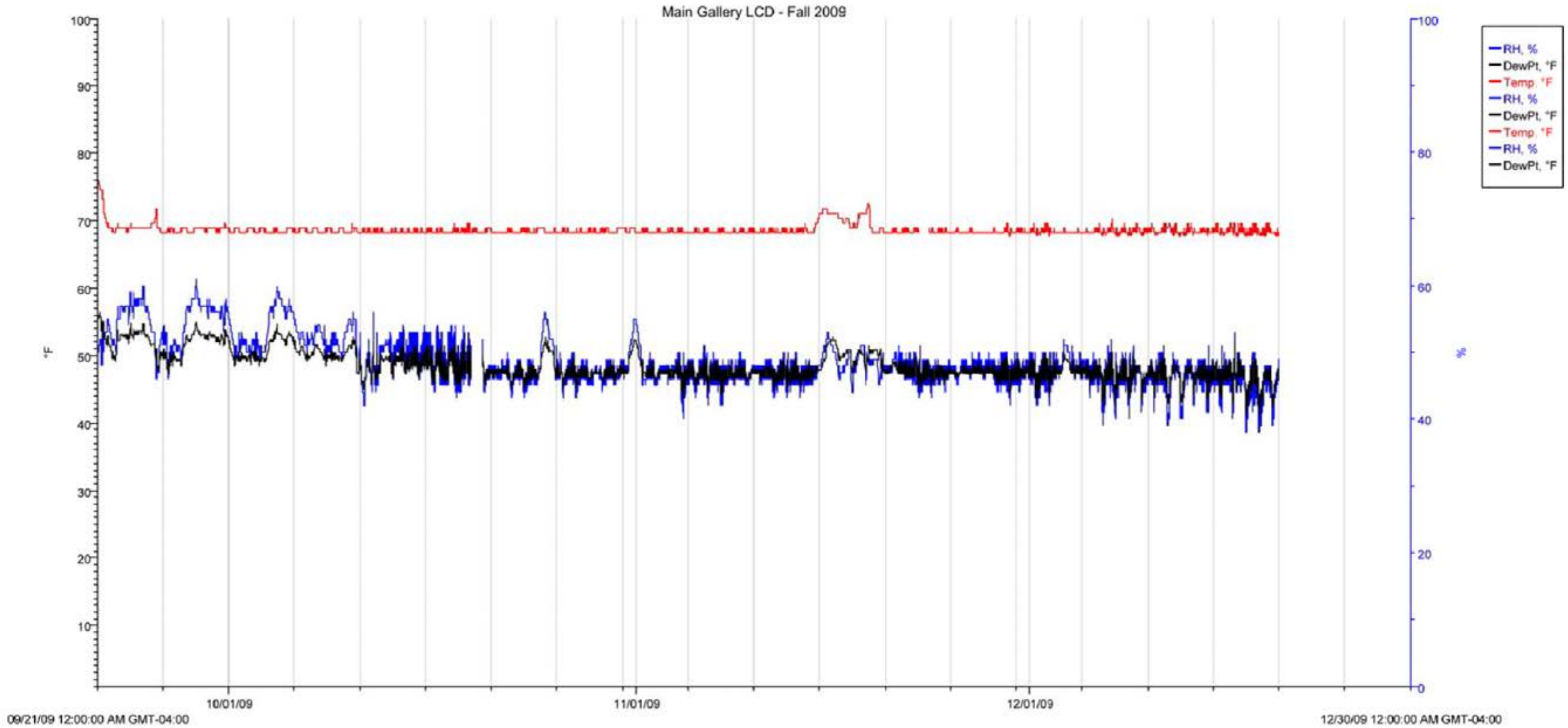
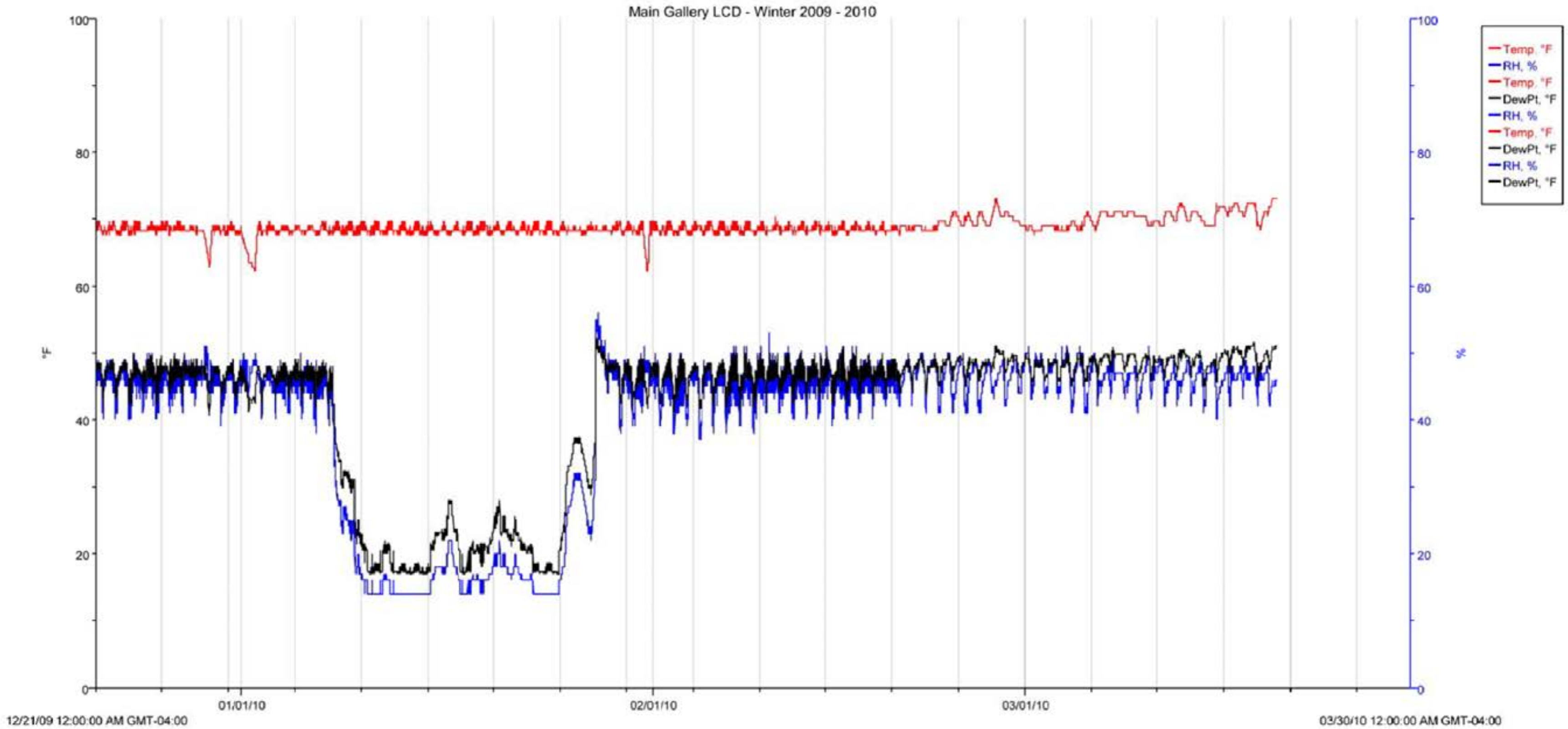

Collections Storage LCD Summer 2010
100
80
60
40
20
0
°F
%
Temp, °F
RH, %
DewPt, °F
07/01/10
08/01/10
09/01/10
06/21/10 12:00:00 AM GMT-04:00
09/30/10 12:00:00 AM GMT-04:00

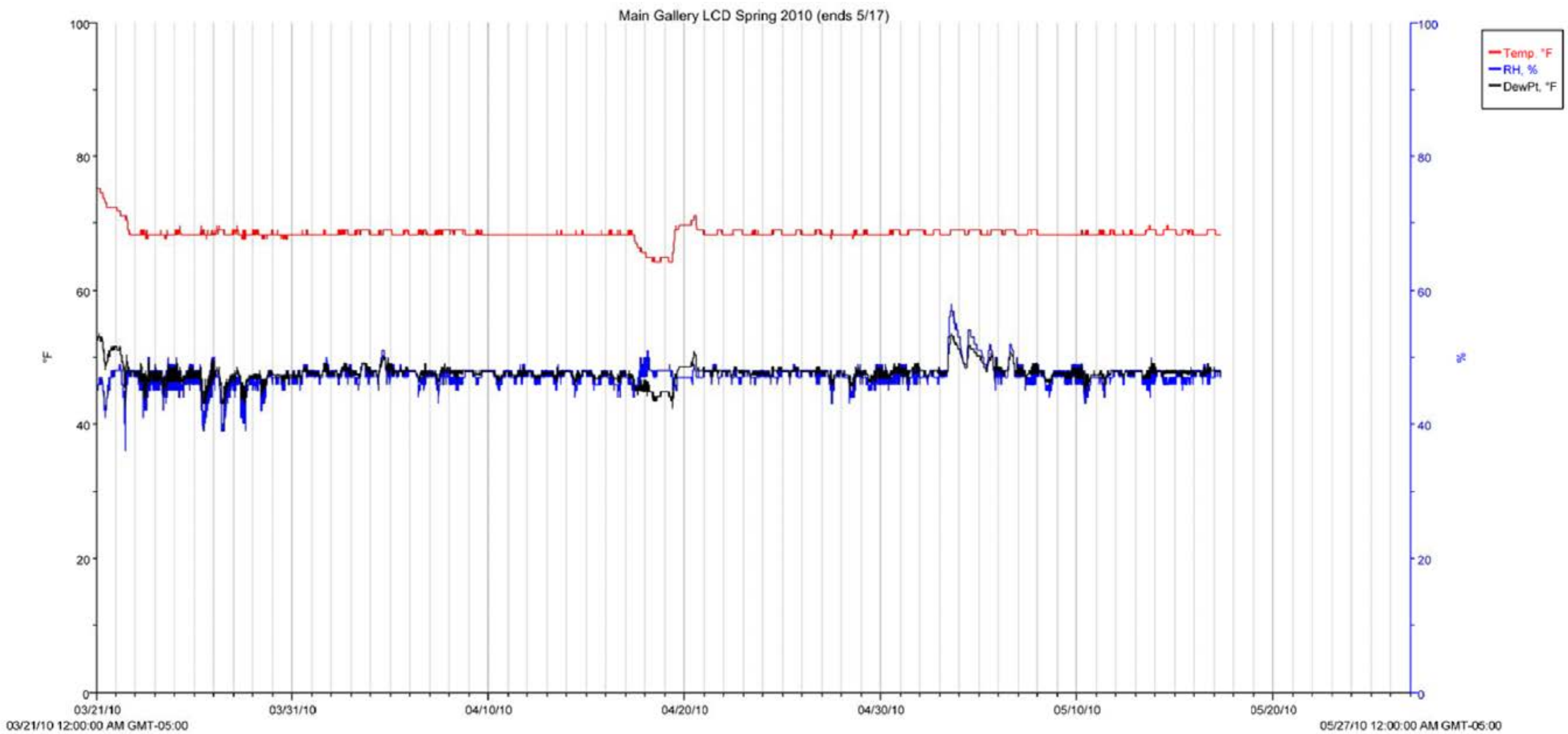
Seasonal Data: Collections Storage [012] HOBO H08 (10 minute logging intervals)						
Variable		Autumn 2009	Winter 2010	Spring 2010 (3/21-5/16)	Summer 2010	Analysis & Comments
Dry Bulb Temp °F	Ave	65.9	66.9	66.2	66.0	T limits meet Class AA. Seasonal ΔT within Class AA limits.
	Max	73.2	72.5	75.9	66.3	
	Min	65.6	62.9	63.5	65.6	
	Seasonal Range	7.6	9.6	12.4	.7	
	Max 24 hr range	6.9	4.1	9.0	.7	100% of 24 hr ΔT within Class AA limits for Autumn, Winter & Summer. 97% of 24 hr ΔT within Class AA limits for Spring.
	Max 24 hr standard deviation	2.5	1.3	2.3	.3	
Dew Point Temp °F	Ave	No data	No data	No data	No data	Dew Point Temperatures will be similar to Collections Storage [012]HOBO H14 data.
	Max	No data	No data	No data	No data	
	Min	No data	No data	No data	No data	
Relative Humidity %	Ave	51.4	43.2	50.9	57.1	RH limits within Class A (float) in autumn, spring & summer, but lo RH in Winter only meets Class D due to humidifier outage. Seasonal ΔRH meets Class A (float) in autumn, spring & summer, but only Class C in Winter due to humidifier outage.
	Max	59.5	52.2	59.5	62.0	
	Min	46.5	15.4	43.4	50.1	
	Seasonal Range	13.0	36.8	16.1	11.9	
	Max 24 hr range	10.4	17.4	8.4	5.2	100% of 24 hr ΔRH within Class A (float) in spring & summer, and nearly 100% in Autumn, but 24 hr ΔRH in Winter only meets Class B due to humidifier outage
	Max 24 hr standard deviation	3.3	8.7	2.4	1.5	
TWPI (Years)		45.0 (moderate)	55.0 (moderate)	49.0 (moderate)	41.0 (moderate)	Rate of deterioration of paper-based materials
Mold Risk Factor		0 (none)	0 (none)	0 (none)	0 (none)	Potential for mold growth in paper-based materials

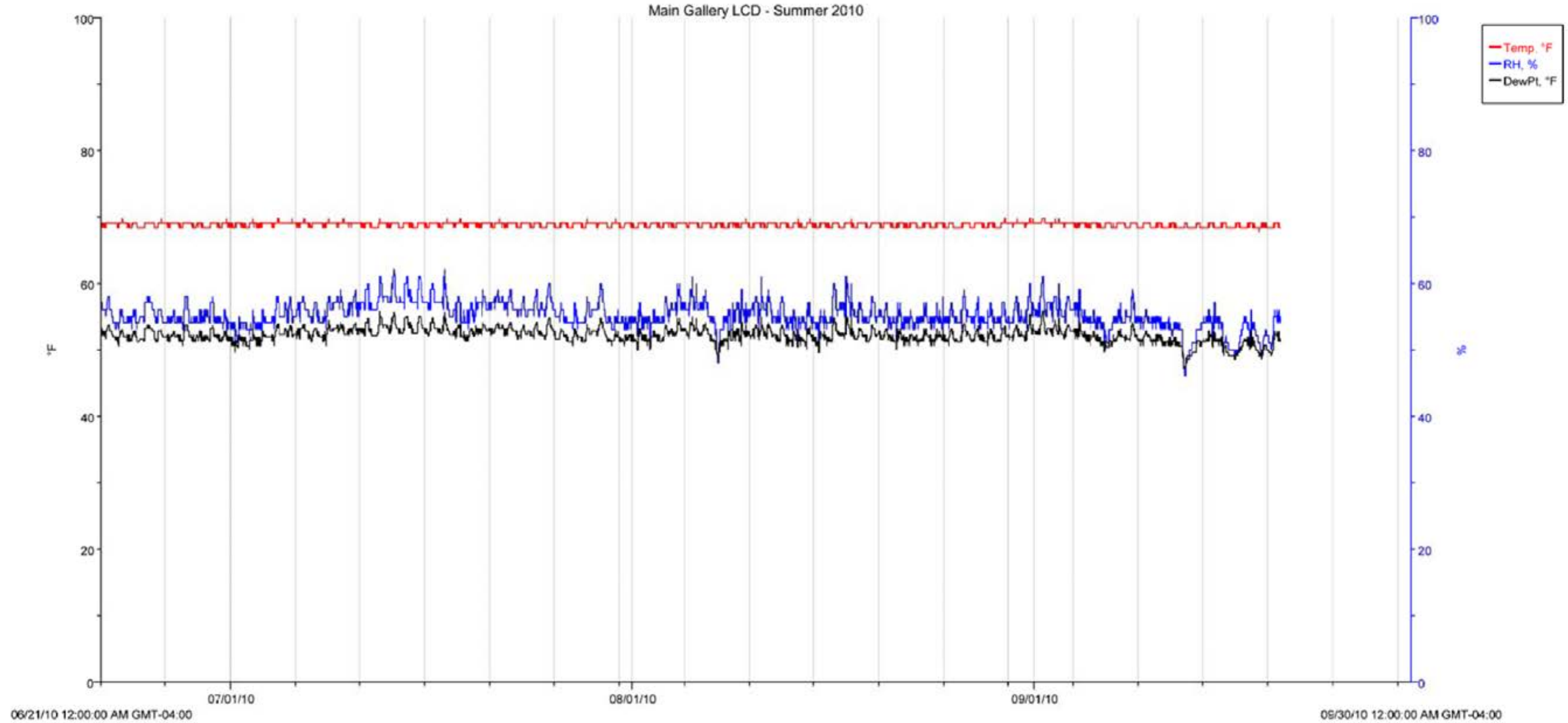
Seasonal Data: Main Gallery [117/118] HOBO H14 (10 minute logging intervals)						
Variable		Autumn 2009	Winter 2010	Spring 2010 (3/21-5/16)	Summer 2010	Analysis & Comments
Dry Bulb Temp °F	Ave	68.7	69.0	68.5	68.8	T limits meet Class AA. Seasonal ΔT within Class AA limits.
	Max	76.6	75.9	75.9	69.7	
	Min	67.6	62.2	64.2	67.6	
	Seasonal Range	9.0	13.7	11.7	2.1	
	Max 24 hr range	7.6	7.5	5.5	1.4	100% of 24 hr ΔT within Class AA limits. .
	Max 24 hr standard deviation	2.8	2.5	2.3	.4	
Dew Point Temp °F	Ave	48.5	42.0	47.6	52.1	Low DpT event in winter due to humidifier outage 1/7 -1/27.
	Max	56.7	53.1	53.6	55.8	
	Min	41.2	16.9	42.3	47.3	
Relative Humidity %	Ave	48.7	39.9	47.2	55.1	RH limits within Class A (float) in autumn, spring & summer, but lo RH in Winter only meets Class D due to humidifier outage. Seasonal ΔRH meets Class A (float) in summer; Autumn & Spring are marginally outside Class A (Float) range. Winter is Class C due to humidifier outage.
	Max	61.0	56.0	58.0	62.0	
	Min	38.0	14.0	36.0	46.0	
	Seasonal Range	23.0	42.0	22.0	16.0	
	Max 24 hr range	13.0	33.0	13.0	8.0	66% of 24 hr ΔRH (± 1 standard deviation) within Class AA limits except for winter humidifier excursion. 97% of 24 hr ΔRH (± 2 standard deviations) within Class B limits except for winter humidifier excursion..
	Max 24 hr standard deviation	3.3	13.9	3.9	2.7	
TWPI (Years)		43.0 (moderate)	54.0 (moderate)	47.0 (moderate)	37.0 (moderate)	Rate of deterioration of paper-based materials
Mold Risk Factor		0 (none)	0 (none)	0 (none)	0 (none)	Potential for mold growth in paper-based materials



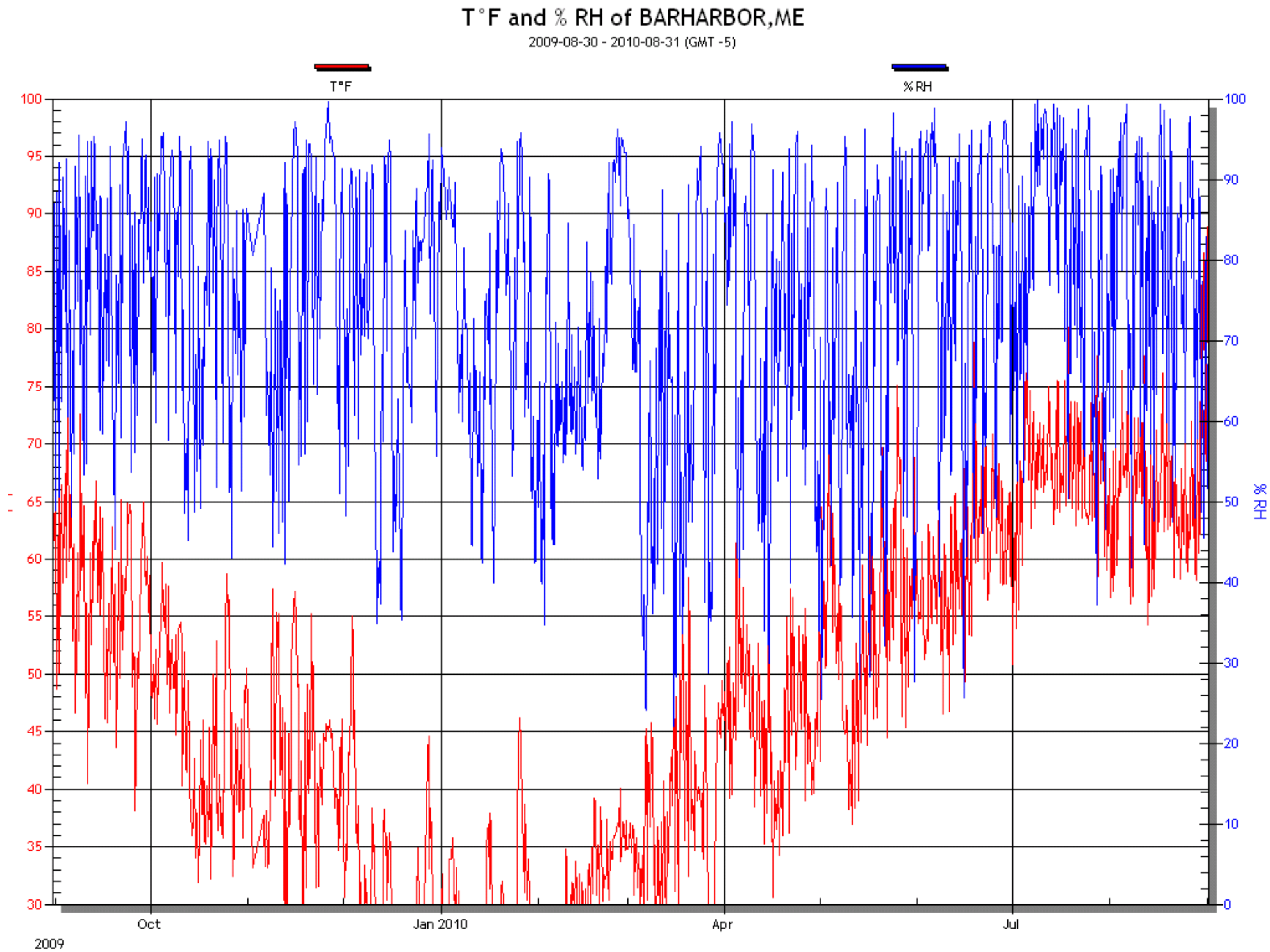
Main Gallery LCD - Fall 2009
°F
%
RH, %
DewPt, °F
Temp, °F
RH, %
DewPt, °F
Temp, °F
RH, %
DewPt, °F
09/21/09 12:00:00 AM GMT-04:00
10/01/09
11/01/09
12/01/09
12/30/09 12:00:00 AM GMT-04:00

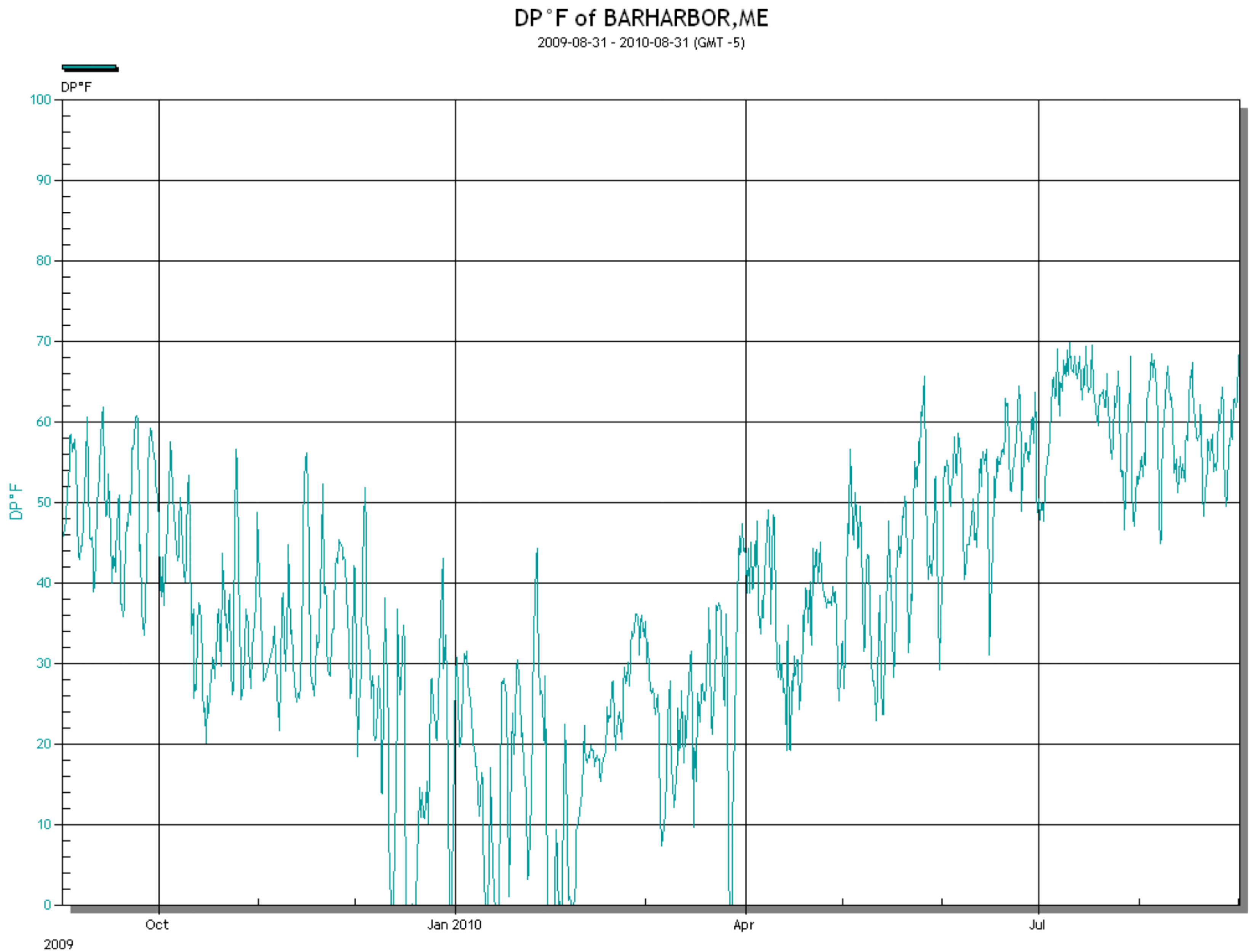

Main Gallery LCD - Winter 2009 - 2010
°F
%
100
80
60
40
20
0
01/01/10
02/01/10
03/01/10
12/21/09 12:00:00 AM GMT-04:00
03/30/10 12:00:00 AM GMT-04:00
Temp, °F
RH, %
Temp, °F
DewPt, °F
RH, %
Temp, °F
DewPt, °F
RH, %
DewPt, °F


Main Gallery LCD Spring 2010 (ends 5/17)
Temp, °F
RH, %
DewPt, °F
°F
%
100
80
60
40
20
0
03/21/10
03/31/10
04/10/10
04/20/10
04/30/10
05/10/10
05/20/10
03/21/10 12:00:00 AM GMT-05:00
05/27/10 12:00:00 AM GMT-05:00


Main Gallery LCD - Summer 2010
Temp, °F
RH, %
DewPt, °F
°F
%
100
80
60
40
20
0
07/01/10
08/01/10
09/01/10
06/21/10 12:00:00 AM GMT-04:00
09/30/10 12:00:00 AM GMT-04:00

Seasonal Data: Main Gallery [117/118] HOBO H08 (30 minute logging intervals)						
Variable		Autumn 2009	Winter 2010	Spring 2010 (3/21-5/16)	Summer 2010	Analysis & Comments
Dry Bulb Temp °F	Ave	No data	67.4	67.3	68.2	
	Max		74.5	72.5	70.4	
	Min		60.8	62.9	66.3	
	Seasonal Range		13.7	9.6	4.1	
	Max 24 hr range		8.2	6.2	2.8	
	Max 24 hr standard deviation		2.0	2.1	0.8	
Dew Point Temp °F	Ave		42.7	44.6	48.5	
	Max		51.4	50.1	52.8	
	Min		27.2	39.7	43.2	
Relative Humidity %	Ave		41.9	43.9	49.3	
	Max		56.5	53.2	56.7	
	Min		23.4	35.0	40.1	
	Seasonal Range		33.1	18.2	16.6	
	Max 24 hr range		33.0	14.3	13.6	
	Max 24 hr standard deviation		12.2	2.7	2.9	
TWPI (Years)			57.0 (moderate)	53.0 (moderate)	45.0 (moderate)	Rate of deterioration of paper-based materials
Mold Risk Factor			0 (none)	0 (none)	0 (none)	Potential for mold growth in paper-based materials


T°F and % RH of BARHARBOR,ME
2009-08-30 - 2010-08-31 (GMT -5)
T°F
%RH
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
100
90
80
70
60
50
40
30
20
10
0
% RH
Oct
Jan 2010
Apr
Jul
2009


DP°F of BARHARBOR,ME
2009-08-31 - 2010-08-31 (GMT -5)
DP°F
100
90
80
70
60
50
40
30
20
10
0
DP°F
Oct
Jan 2010
Apr
Jul
2009

Appendix B

Recommended Environmental Management Improvements

LIGHTING & ELECTRICAL IMPROVEMENTS FOR REDUCED ENERGY CONSUMPTION

Action	Responsibility	Target Dates
Relamp all non-exhibit/collections spaces with fluorescent lamps at the lowest necessary wattage. • All fixtures in public spaces must have lamps. • Contact suppliers for technical assistance.	Abbe Museum staff	June 2012 (complete)
Relamp Main Gallery [117/118] exhibit fixtures with lower wattage lamps. • Less wasted energy for dimming and better color rendering. • Replace existing 50W lamps with 20W or 35W lamps and similar beam spreads. • Contact suppliers for technical assistance.	Abbe Museum staff	September 2012 (complete)
Reduce electricity use and related electric utility charges, including peak demand. • Start an in-house awareness campaign of the cost of unnecessary electric power consumption. • Use local task/work lights, not exhibit lights, for local work/cleaning in Main Gallery [117/118].	Abbe Museum staff	June 2012 (complete)
Refit the Community Gallery [110] with museum-quality LED lamps and fixtures. • Pilot project to inform future redesign of Main Gallery [117/118] lighting. • Determine whether or not dimmer must be changed out for compatibility with LED lamps. • Investigate eligibility for energy-saving rebate. • Use pilot project for in-house testing and evaluation as well as public education.	Abbe Museum staff with Ron Harvey.	December 2012 (complete)
Redesign Main Gallery [117/118] exhibit lighting to improve interpretation and reduce energy use: • Apply for NEH implementation funding (2012). • Use experience for Community Gallery LED lighting pilot project. • Reduce fixture height and “wasted” light of exhibit lighting. • Consider low level ambient space lighting with LED exhibit lighting mounted in the cases. • Consider eliminating the complex theatrical lighting controls used for the Main Gallery. • Apply for NEH implementation funding.	Abbe Museum staff with Ron Harvey & lighting designer	January 2012 (start) April 2014 (complete)
Redesign Exhibition Hallway [109] lighting for lower wattage and better aesthetic effect.	Abbe Museum staff w. Jon Traficonte	April 2014 (complete)

PASSIVE MEASURES FOR INTERIOR ENVIRONMENTAL STABILITY TO REDUCE DEMAND ON HVAC SYSTEM

Action	Responsibility	Target Dates
Reduce air exchange between collections zones and non-collections zones for better RH control. • Keep doors closed (except when entering/leaving) between: Main Gallery [117/118]/Exhibition Hallway [109]; Collections Storage [012]/Collections Management Office [011]; Collections Management Office [011]/corridor [002]. • Check gaskets on above-listed doors and repair/replace if needed.	Abbe Museum staff	Immediately
Reduce temperature instability and air flow problems in non-collections zones for lower energy use and better visitor comfort. Keep doors closed between: • Orientation Gallery [103]/ Exhibition Hallway [109]; • Education Gallery [110]/Exhibition Hallway [109]. Note: the Education Gallery doors block air flow to the return air registers and block the temperature sensor when the doors are open. To keep these doors closed, the doors and hardware must be replaced for egress code compliance.	Abbe Museum staff	December 2012
The existing exhibit cases appear to be effective buffers for temperature and RH fluctuations in the Main Gallery [117/118]. If so, very tight control of the Main Gallery may be unnecessary and energy consumption and costs could be reduced if the environmental criteria for the Main Gallery are relaxed to a wider range. The following actions should be undertaken to evaluate this possibility: • Determine the efficacy of the existing cases for buffering fluctuations by monitoring conditions inside cases in Main Gallery. Compare in-case data to Main Gallery data and determine beneficial performance. Identify simple modifications to the cases that might improve buffering, such as gaskets. • If exhibit cases are found to be effective buffers, determine if environmental criteria for Main Gallery be changed to save energy and costs; • If Main Gallery environmental criteria are changed, determine the implications for: 1. Collections Storage [012], which is on the same HVAC zone; 2. Large, uncased objects. Evaluate the feasibility of a case for the exhibited canoes; 3. Loaned objects.	Abbe Museum staff with Ron Harvey.	January 2012 (start) January 2013 (complete)

PASSIVE MEASURES FOR INTERIOR ENVIRONMENTAL STABILITY TO REDUCE DEMAND ON HVAC SYSTEM (continued)

Action	Responsibility	Target Dates
If the environmental control criteria for the Gallery/Storage HVAC zone are changed, it may be necessary to improve temperature and relative humidity stability in Collections Storage [012]. • Test methods for buffering the stored canoes. Construct a polysheet enclosure with weighted snakes or Velcro closures, vision panels, and cotton/paper buffers below the shelving units. Monitor for 12 months (comparative monitoring with space conditions, similar to the exhibit case tests above. • Test methods to improve buffering performance of mobile shelving units. Load collections storage with buffer material (cotton or paper).	Abbe Museum staff with Ron Harvey.	January 2012 (start) January 2013 (complete)
Reduce heat loss/gain in the Orientation Gallery [103]. • Investigate interior/exterior storm windows and install.	Abbe Museum staff with Jon Traficonte	Fall 2012 (start/complete)
Reduce solar gain in Learning Lab [004]. Cooling loads in this space may be driving unnecessary chiller operation. • Install light reducing shades and keep closed except when this space is occupied.	Abbe Museum staff	Fall 2012 (start/complete)

HVAC SYSTEM IMPROVEMENTS FOR IMPROVED EFFICIENCY AND REDUCED ENERGY CONSUMPTION (ELECTRICITY & FUEL OIL)

Action	Responsibility	Target Dates
Reduce air infiltration into Main Gallery [117/118]; air infiltration increases humidification/ dehumidification loads. • Rebalance supply and return ducts for AHU 1 (collections) zone so supply flow = return flow. • Rebalance intake and exhaust air flow through Heat Recovery ventilator HR-1.	Abbe Museum staff with David Clay	Immediately (start/complete)
Improve accuracy, transparency and human interface of HVAC controls: • Calibrate existing sensors (checked 20 April 2011). Recalibrate every 12 months. • Replace relative humidity sensors in AHU 1 (collections) zone with more accurate, more reliable sensors manufactured by Vaisalla. • Upgrade the HVAC control system software for more transparency and easier comprehension and for easier adjustment and trending of conditions and operation (approximately $10K).	Abbe Museum staff with David Clay	April 2012 (complete) September 2012 (complete) January 2013 (complete)
Improve reliability and performance of humidifier in AHU 1 (collections) zone. • Repipe steam humidifier supply line to humidifier nozzle and provide 2 inch/foot slope for proper condensate drainage away from nozzle, per manufacturer's instructions. Reinsulate supply piping. • Test supply water to humidifier and add Reverse Osmosis-Demineralized water treatment to water supply (Humidifier model number indicates that RO-DI water is needed). • Relocate heat recovery tank and blow-down piping for easier access. Blow-down tank once per month to clear solids.	Abbe Museum staff with David Clay	Fall 2012
Modify operation of Heat Recovery unit HR-1 to improve moisture vapor control in the collections zone: • Check the enthalpy (moisture exchange wheel) for media condition and particulate accumulation. • Eliminate "free cooling" without operation of enthalpy wheel. Free cooling without the enthalpy wheel increases humidification load in winter and increases dehumidification load during cool damp periods. • Reduce outside air component to reflect true ventilation requirement for occupant load • Adjust HR-1 runtime if needed – probably only in peak season Reprogram 10 minutes per hour between scheduled visiting hours.	Abbe Museum staff with David Clay	April 2012 (start/complete)

HVAC SYSTEM IMPROVEMENTS FOR IMPROVED EFFICIENCY AND REDUCED ENERGY CONSUMPTION (ELECTRICITY & FUEL OIL)

Action	**Responsibility**	**Target Dates**
Modify operation of Heat Recovery units HR-1 and HR-2 to reduce unnecessary outside air exchange and reduce energy costs: • Install variable speed drives (both units) 4 motors and modify controls for demand based ventilation ($15k grantable)	Abbe Museum staff with David Clay	December 2012 (start) April 2014 (complete)
Reduce use of chilled water dehumidification with hot water reheat during seasons with latent cooling load (dehumidification) but low sensible cooling load (moderate temperatures): • Add dedicated dehumidification equipment (high efficiency direct expansion or desiccant wheel) to AHU 1 (collections) zone for first stage dehumidification. • Use chilled water system for stage 2 dehumidification.	Abbe Museum staff with David Clay	December 2012 (start) April 2014 (complete)
Reduce unnecessary heating and cooling cycling caused by tight control requirements in AHU-2 zone (non-collections area): • Raise the cooling setpoint for winter and lower the heating set point for summer for 3 °F offset. • Implement reset of hot water supply temperature for boilers based on outside air temperature (lower hot water supply temp on milder days).	Abbe Museum staff with David Clay	Immediately (start/complete)
Begin reinvestment planning for chiller overhaul/replacement at end of service life.	Abbe Museum staff with David Clay	2012 (start/complete)

Appendix C

Observations and Recommendations of Collections Conservation Consultant
Ronald S. Harvey, Tuckerbrook Conservation

Collections conservator Ronald S. Harvey describes the collections and their environmental vulnerabilities as follows.

The collections housed in the Abbe Museum building located in downtown Bar Harbor are comprised of both inorganic and organic collections. The collections reflect the cultural, historical and artistic expression of the Wabanaki people.

The primary collections areas, the storage room in the lower level of the building and the large exhibit gallery on the first floor, house the majority of the collections. The organic collections are most at risk when there are radical swings in relative humidity and temperature resulting in these fragile collections attempting to adjust to their environment. The basketry collection is prone to damage as these collections are made from manipulated natural material, such as wood from ash trees, that has been delaminated, soaked and woven to form a variety of baskets. The thin sections of split ash expose surfaces of the wood to the environment and are ever striving to equilibrate with the ambient relative humidity.

Composite collections made from birch bark and wood elements such as canoes are under some level of stress due to construction techniques and are also susceptible to tension and compression as a result of abrupt and radical changes in ambient relative humidity in the museum environment. Collections comprised of hide or skins are prone to damage from high or low interior relative humidity as these objects attempt to equilibrate to the ambient relative humidity. Archival materials in the form or rare books and documents are also at risk of micro-organism activity in the event of sustained high relative humidity.

Exhibit Gallery: The exhibit gallery was designed to hold a stable relative humidity with seasonal adjustments in the spring and the fall, 40-60% winter to summer with gradual adjustments that would not adversely affect the collections. Maintaining a stable environment within the exhibition gallery will provide the most effective protection for the collections on exhibit however the history of mechanical failure or errant high/low relative humidity when the HVAC system falters can result in damage to the collections. The recommendation to maintaining the current standards for the museum environment as defined by ASHRAE and isolating organic collections on exhibit within vitrines or cases would buffer the collections from radical or sustained environmental anomalies when there is HVAC falters or failings.

Exhibit Cases: Installing a silicone D or teardrop shaped adhesive backed gaskets[1] on the lower edge of the acrylic vitrines will provide a more complete seal with deck material. Whenever possible it is suggested that a recessed channel be included in the construction of bases or supports for vitrines. The recessed channel can contain the silicone gasket and extend the life of the seal. Recessed channels also provide a means of installing security screws to further protect the collections housed in the vitrines while on exhibit. Retrofitting the Hahn exhibit cases to close gaps and therefore create a greater and complete seal of the cases will buffer the collections while on exhibit. Gaps and openings in the case (door, joints, etc.) can be closed using silicone gaskets, expanded polyethylene foam (white) or closed cell polyethylene foam (Volara) available in white or black.

Identify retrofitted cases and undertake environmental monitoring using HOBO dataloggers to determine effectiveness of retrofit and buffering effect of exhibit cases. This information will be needed to determine the acceptable range of temperature and relative humidity fluctuations within the gallery if all organic collections on exhibit are housed in exhibit cases. Changing the exhibit gallery environmental range may have ramifications for potential loaned collections and it will directly affect the storage environment. Large oversized items on exhibit in the gallery limit the potential of altering the environment unless a flexible closed case system is available to address the large objects, such as a canoes, while on exhibit.

Lighting: The current halogen lamping of the exhibit gallery has an immense impact on the HVAC system, introducing heat that will affect the air conditioning in cooling mode and the relative humidity in heating mode. A rational approach to the lighting issue would be to replace the existing MR 16 lighting with light emitting diode (LED) lights. LED lighting in museums is gaining support and the cost for the LED lights is decreasing month to month however all LED lighting is not appropriate for museum collections.

[1] Clean Seal, Inc. silicone rubber gaskets with adhesive backing. Clean Seal, Inc., 20900 W. Ireland Road, South Bend, IN 46614 www.**cleanseal**.com

The recommended approach for the Abbe Museum would be to undertake a pilot approach to testing LED lighting in the Community Gallery (110) with LED lights that are currently known to meet museum standards[2]. The retrofit would allow the staff to review the public response, monitor power use and savings as well as establish compatibility with the current lighting systems within the museum. Tuckerbrook Conservation LLC will work with the Abbe staff to determine the most effective LED lighting that can be used with the current lighting system and undertake the pilot program. The review will determine if the current dimmer system in the Community Gallery will require replacement to accommodate the new LED lighting. Current thinking is to replace incandescent bulbs with LED bulbs that are compatible with the existing lighting systems as this is most economical. The field of LED lighting and track systems is emerging and it would be most reasonable to delay the major purchase of a new lighting system until the field has further developed and systems are sustainable and more economical. Information gained from the pilot project can be used to guide the relamping of the main exhibit gallery, lighting hardware upgrade or replacement of existing theater lighting system, reduce fixture height to eliminate loss of light (projection) and adjust ambient lighting in gallery to make exhibit lighting more effective and reduce excess energy use.

Collection Storage: If the Gallery interior case environmental data suggests altering the HVAC system to address a wider range in temperature and relative humidity it will then be necessary to improve temperature and relative humidity in Collection Storage (012). The collections in storage identified as being at the greatest risk in an unstable environment are the birchbark canoes followed by the baskets.

Canoes are currently stored on a custom designed wall mounted, padded metal frame. The canoes are covered with Tyvek to protect the surfaces from dust and reduce light exposure. The canoes in storage do not have any mechanisms for buffering in the event of sudden changes in the storage environment. It is important that the canoes remain visible to the staff while in storage. It is recommended that the canoes be isolated by designing and installing a wall and buffering system to isolate the canoes from changes in the environment and also have a buffering effect in the event of radical or sudden changes in the environment in the event of HVAC failure or malfunction. Create an enclosure using 6 mil polyethylene sheeting, secured to the ceiling and floor of the room with a ZipWall[3] system, the addition of Velcro, magnets or mechanical fasteners may be needed to form a tight seal along the ceiling of the room and use sand snakes, small sand bags and double sided tape to create a space that will contain the canoes and install a zipper door that will access into the enclosure. Install a buffering material such as cotton batting in muslin bags, paper. The effectiveness of the system will depend on the tightness of the surrounding "walls" and the degree of flux in the storage environment. This system could be tested using a model and datalogger to determine the effectiveness of the poly walls, the seals and the amount of buffering material needed per square foot. Based on model testing the full scale poly wall unit could be constructed and further tested using dataloggers to determine its effective range.

The mobile system in storage houses the majority of the basket in the collection. The baskets reside on padded open shelving or in acid free corrugated board boxes. The compacter shelving closes, however it is not a tight seal and the environment within the shelving unit reflects the storage room environment. Short of rehousing all of the baskets into acid free boxed there is no easy way of buffering them form radical changes in the environment. Ideally, continuing the use of the HVAC system and if necessary modifying the storage environment by introducing stand alone dehumidification if needed. In the event of HVAC failure or power outage I would advise based on the length of time off line and ambient readings, to gradually bring up the temperature and relative humidity to reduce the potential of damage to collections in storage.

Continue to monitor storage room and gallery environment using accurate dataloggers such as the HOBO Pro v2 Temperature and relative humidity logger. Install HOBO Pro V2 with external probe to monitor exterior building environment.

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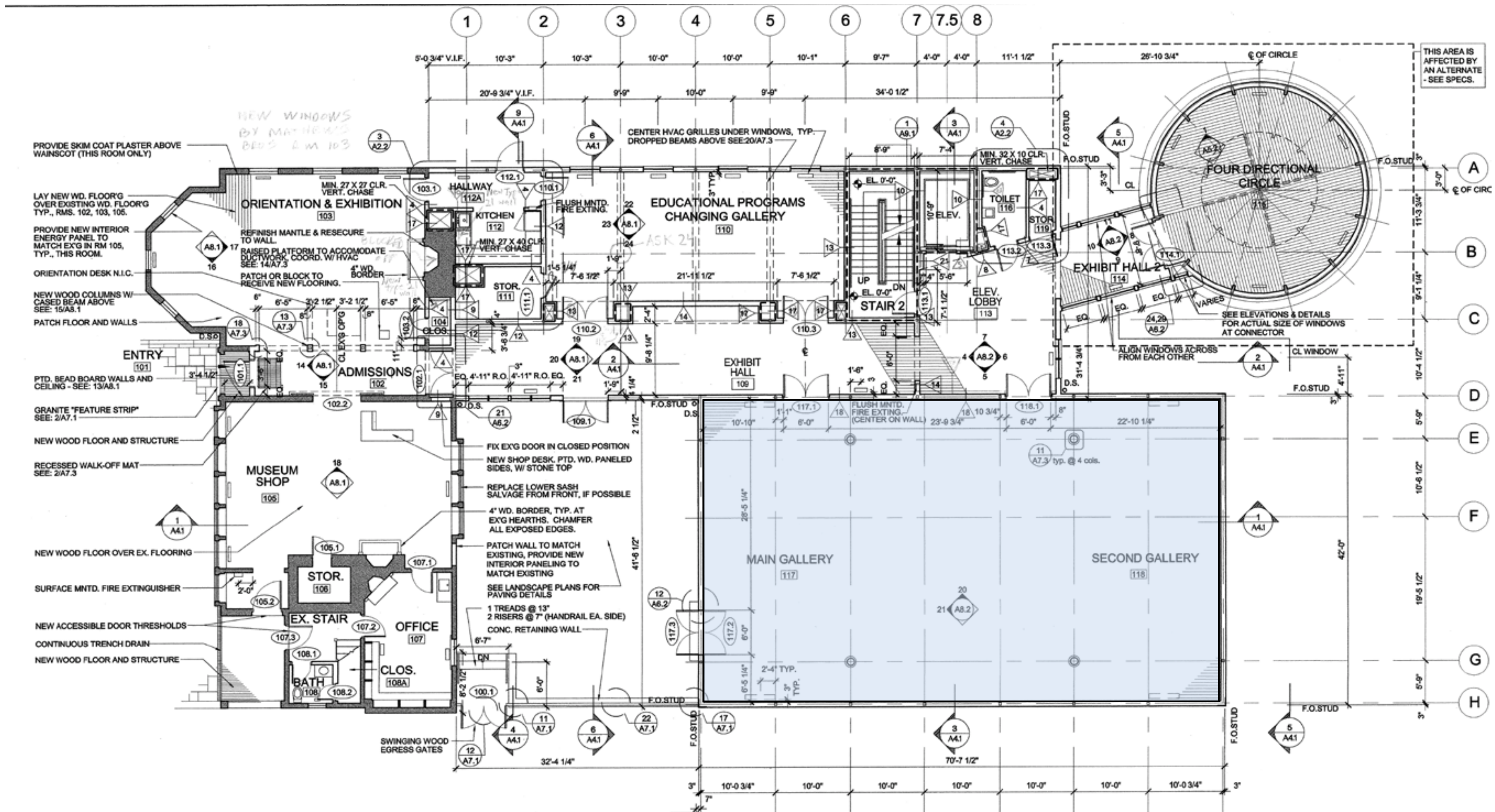
[2] *Using Risk Assessment Tools to Evaluate the Use of LEDs for the Illumination of Light-Sensitive Collections* by Steven Weintraub (PDF of article that was originally published in *AIC News*, September 2010.)
Guidelines for Selecting Solid-State Lighting for Museums by James R. Druzik and Stephan W. Michalski, Canadian Conservation Institute & The Getty Conservation Institute, September 2011.
[3] www.zipwall.com

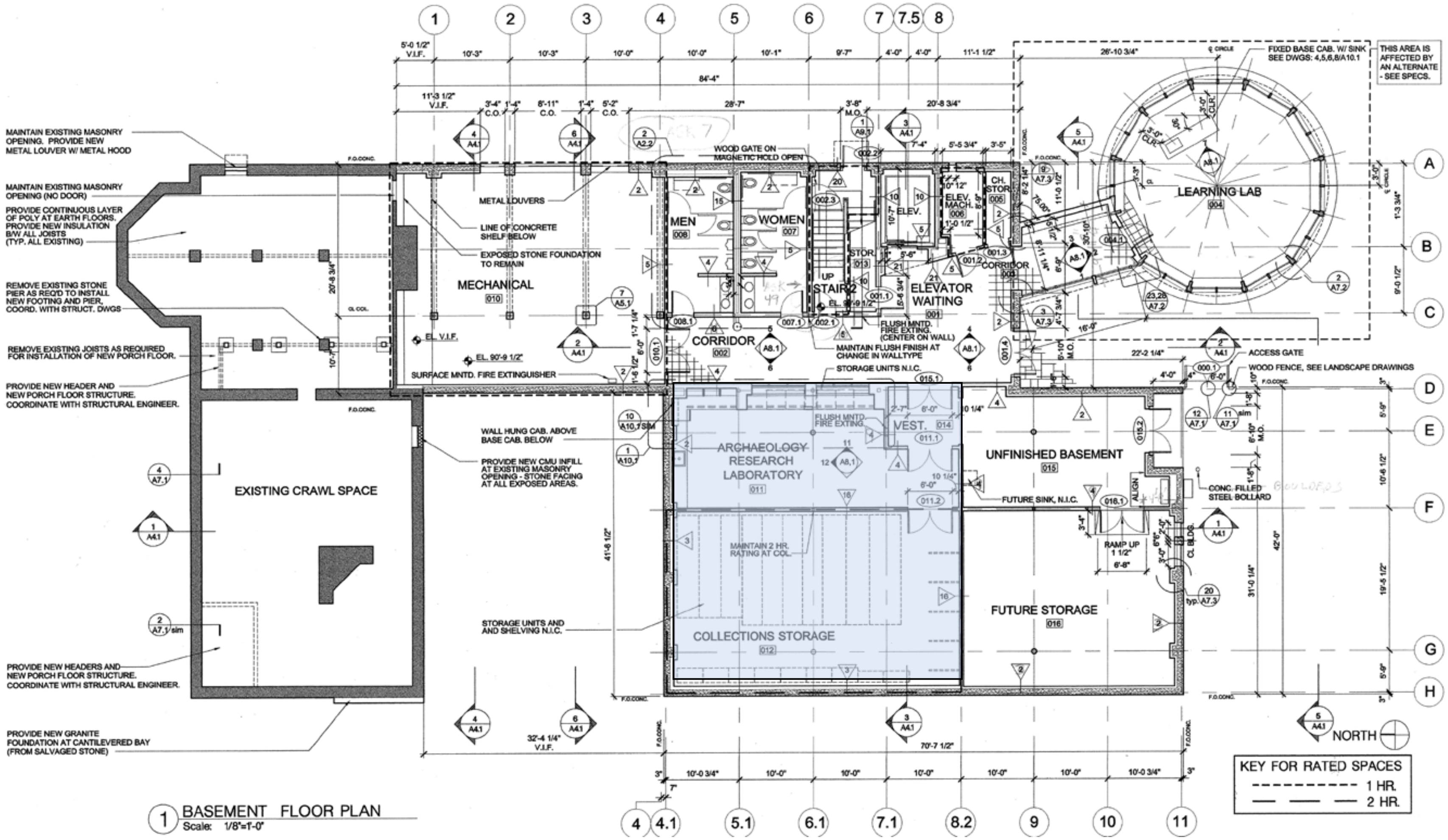
Appendix D

Architectural Floor Plans, Extracted from Abbe Museum Drawing A1.1 by Schwartz/Silver Architects, Inc.

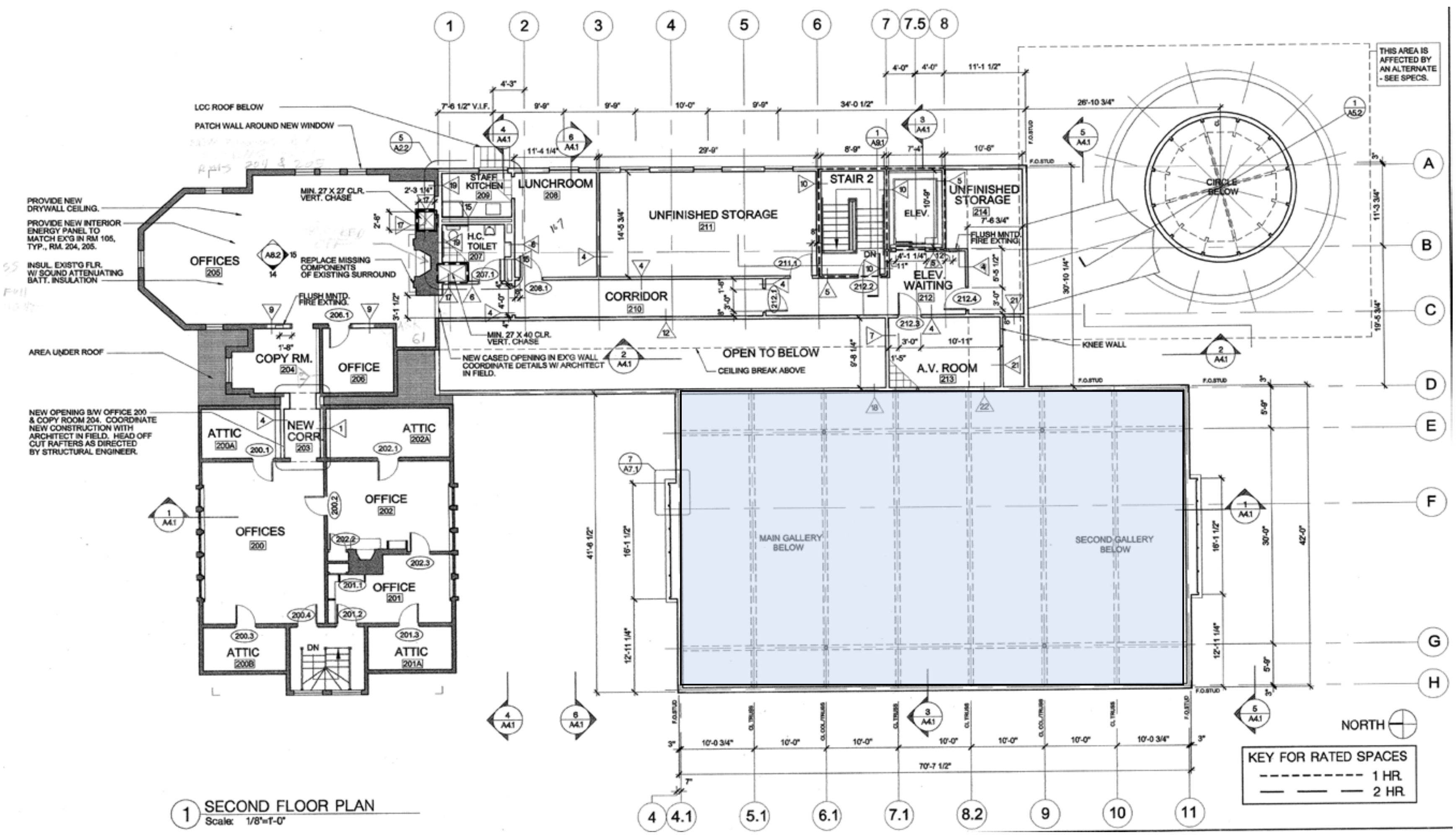
Collections areas are highlighted as:



2 FIRST FLOOR PLAN
Scale: 1/8"=1'-0"



MAINTAIN EXISTING MASONRY OPENING. PROVIDE NEW METAL LOUVER W/ METAL HOOD
MAINTAIN EXISTING MASONRY OPENING (NO DOOR)
PROVIDE CONTINUOUS LAYER OF POLY AT EARTH FLOORS. PROVIDE NEW INSULATION B/W ALL JOISTS (TYP. ALL EXISTING)
REMOVE EXISTING STONE PIER AS REQ'D TO INSTALL NEW FOOTING AND PIER, COORD. WITH STRUCT. DWGS
REMOVE EXISTING JOISTS AS REQUIRED FOR INSTALLATION OF NEW PORCH FLOOR.
PROVIDE NEW HEADER AND NEW PORCH FLOOR STRUCTURE. COORDINATE WITH STRUCTURAL ENGINEER.
EXISTING CRAWL SPACE
PROVIDE NEW HEADERS AND NEW PORCH FLOOR STRUCTURE. COORDINATE WITH STRUCTURAL ENGINEER.
PROVIDE NEW GRANITE FOUNDATION AT CANTILEVERED BAY (FROM SALVAGED STONE)
METAL LOUVERS
LINE OF CONCRETE SHELF BELOW
EXPOSED STONE FOUNDATION TO REMAIN
MECHANICAL
010
SURFACE MNTD. FIRE EXTINGUISHER
WALL HUNG CAB. ABOVE BASE CAB. BELOW
PROVIDE NEW CMU INFILL AT EXISTING MASONRY OPENING - STONE FACING AT ALL EXPOSED AREAS.
STORAGE UNITS AND AND SHELVING N.I.C.
WOOD GATE ON MAGNETIC HOLD OPEN
MEN
008
WOMEN
007
CORRIDOR
002
STAIR 2
ELEV.
ELEVATOR WAITING
001
FLUSH MNTD. FIRE EXTING. (CENTER ON WALL)
MAINTAIN FLUSH FINISH AT CHANGE IN WALLTYPE
STORAGE UNITS N.I.C.
ARCHAEOLOGY RESEARCH LABORATORY
011
VEST.
014
MAINTAIN 2 HR. RATING AT COL.
COLLECTIONS STORAGE
012
UNFINISHED BASEMENT
015
FUTURE SINK, N.I.C.
RAMP UP 1 1/2"
FUTURE STORAGE
016
CONC. FILLED STEEL BOLLARD
ACCESS GATE
WOOD FENCE, SEE LANDSCAPE DRAWINGS
LEARNING LAB
004
FIXED BASE CAB. W/ SINK SEE DWGS: 4,5,6,8/A10.1
THIS AREA IS AFFECTED BY AN ALTERNATE - SEE SPECS.
NORTH
KEY FOR RATED SPACES
1 HR.
2 HR.
1 BASEMENT FLOOR PLAN
Scale: 1/8"=1'-0"


THIS AREA IS AFFECTED BY AN ALTERNATE - SEE SPECS.
LCC ROOF BELOW
PATCH WALL AROUND NEW WINDOW
PROVIDE NEW DRYWALL CEILING.
PROVIDE NEW INTERIOR ENERGY PANEL TO MATCH EX'G IN RM 105, TYP., RM. 204, 205.
INSUL. EXIST'G FLR. W/ SOUND ATTENUATING BATT. INSULATION
AREA UNDER ROOF
NEW OPENING B/W OFFICE 200 & COPY ROOM 204. COORDINATE NEW CONSTRUCTION WITH ARCHITECT IN FIELD. HEAD OFF CUT RAFTERS AS DIRECTED BY STRUCTURAL ENGINEER.
OFFICES
STAFF KITCHEN
LUNCHROOM
UNFINISHED STORAGE
STAIR 2
ELEV.
UNFINISHED STORAGE
H.C. TOILET
CORRIDOR
ELEV. WAITING
COPY RM.
OFFICE
OPEN TO BELOW
CEILING BREAK ABOVE
A.V. ROOM
KNEE WALL
CIRCLE BELOW
ATTIC
NEW CORR
OFFICE
OFFICES
OFFICE
ATTIC
ATTIC
MAIN GALLERY BELOW
SECOND GALLERY BELOW
NORTH
KEY FOR RATED SPACES
1 HR.
2 HR.
SECOND FLOOR PLAN
Scale: 1/8"=1'-0"

Appendix E

Energy Star *Statement of Performance*
for the Abbe Museum
Prepared by David Clay, PE, of Mechanical Services, Inc.

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Abbe Museum

Building ID: 2701864
For 12-month Period Ending: March 31, 2011[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: May 02, 2011

Facility
Abbe Museum
26 Mt. Desert St.
Bar Harbor, ME 04609

Facility Owner
Abbe Museum
26 Mt. Desert St.
Bar harbor, ME 04609

Primary Contact for this Facility
John Brown
26 Mt. Desert St.
Bar harbor, ME 04609

Year Built: 2000
Gross Floor Area (ft²): 15,668

Energy Performance Rating[2] (1-100) N/A

Site Energy Use Summary[3]	
Electricity - Grid Purchase(kBtu)	778,072
Fuel Oil (No. 2) (kBtu)	1,055,698
Natural Gas - (kBtu)[4]	0
Total Energy (kBtu)	1,833,770

Energy Intensity[5]	
Site (kBtu/ft²/yr)	117
Source (kBtu/ft²/yr)	234

Emissions (based on site energy use)	
Greenhouse Gas Emissions ($MtCO_2e$/year)	164

Electric Distribution Utility
Bangor Hydro Electric Co [Emera Inc]

National Average Comparison	
National Average Site EUI	95
National Average Source EUI	265
% Difference from National Average Source EUI	-12%
Building Type	Entertainment/Culture

Stamp of Certifying Professional

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate.

Meets Industry Standards[6] **for Indoor Environmental Conditions:**	
Ventilation for Acceptable Indoor Air Quality	**N/A**
Acceptable Thermal Environmental Conditions	**N/A**
Adequate Illumination	**N/A**

Certifying Professional
David Clay
Mechanical Services, Inc.
Portland, ME 04103

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Values represent energy intensity, annualized to a 12-month period.
5. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

ENERGY STAR® Data Checklist for Commercial Buildings

In order for a building to qualify for the ENERGY STAR, a Professional Engineer (PE) or a Registered Architect (RA) must validate the accuracy of the data underlying the building's energy performance rating. This checklist is designed to provide an at-a-glance summary of a property's physical and operating characteristics, as well as its total energy consumption, to assist the PE or RA in double-checking the information that the building owner or operator has entered into Portfolio Manager.

Please complete and sign this checklist and include it with the stamped, signed Statement of Energy Performance.
NOTE: You must check each box to indicate that each value is correct, OR include a note.

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Building Name	Abbe Museum	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		☐
Type	Entertainment/Culture	Is this an accurate description of the space in question?		☐
Location	26 Mt. Desert St., Bar Harbor, ME 04609	Is this address accurate and complete? Correct weather normalization requires an accurate zip code.		☐
Single Structure	Single Facility	Does this SEP represent a single structure? SEPs cannot be submitted for multiple-building campuses (with the exception of acute care or children's hospitals) nor can they be submitted as representing only a portion of a building		☐

Museum and Offices (Other)

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Gross Floor Area	15,668 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		☐
Number of PCs	8(Optional)	Is this the number of personal computers in the space?		☐
Weekly operating hours	60Hours(Optional)	Is this the total number of hours per week that the space is 75% occupied? This number should exclude hours when the facility is occupied only by maintenance, security, or other support personnel. For facilities with a schedule that varies during the year, "operating hours/week" refers to the total weekly hours for the schedule most often followed.		☐
Workers on Main Shift	8(Optional)	Is this the number of employees present during the main shift? Note this is not the total number of employees or visitors who are in a building during an entire 24 hour period. For example, if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100.		☐

Energy Consumption

Power Generation Plant or Distribution Utility: Bangor Hydro Electric Co [Emera Inc]

Fuel Type: Electricity		
Meter: Electricity (kWh (thousand Watt-hours)) **Space(s):** Entire Facility **Generation Method:** Grid Purchase		
Start Date	**End Date**	**Energy Use (kWh (thousand Watt-hours))**
03/01/2011	03/31/2011	16,040.00
02/01/2011	02/28/2011	17,200.00
01/01/2011	01/31/2011	15,680.00
12/01/2010	12/31/2010	16,680.00
11/01/2010	11/30/2010	16,920.00
10/01/2010	10/31/2010	19,520.00
09/01/2010	09/30/2010	20,920.00
08/01/2010	08/31/2010	24,240.00
07/01/2010	07/31/2010	24,080.00
06/01/2010	06/30/2010	20,600.00
05/01/2010	05/31/2010	17,040.00
04/01/2010	04/30/2010	19,120.00
Electricity Consumption (kWh (thousand Watt-hours))		**228,040.00**
Electricity Consumption (kBtu (thousand Btu))		**778,072.48**
Total Electricity (Grid Purchase) Consumption (kBtu (thousand Btu))		**778,072.48**
Is this the total Electricity (Grid Purchase) consumption at this building including all Electricity meters?		☐

Fuel Type: Fuel Oil (No. 2)		
Meter: Fuel Oil (Gallons) **Space(s):** Entire Facility		
Start Date	**End Date**	**Energy Use (Gallons)**
03/01/2011	03/31/2011	669.70
02/01/2011	02/28/2011	1,298.70
01/01/2011	01/31/2011	413.50
12/01/2010	12/31/2010	1,176.60
11/01/2010	11/30/2010	493.70
10/01/2010	10/31/2010	710.60
09/01/2010	09/30/2010	307.80
08/01/2010	08/31/2010	578.70
07/01/2010	07/31/2010	300.60
06/01/2010	06/30/2010	599.60

05/01/2010	05/31/2010	475.80
04/01/2010	04/30/2010	586.60
Fuel Oil Consumption (Gallons)		**7,611.90**
Fuel Oil Consumption (kBtu (thousand Btu))		**1,055,698.22**
Total Fuel Oil (No. 2) Consumption (kBtu (thousand Btu))		**1,055,698.22**
Is this the total Fuel Oil (No. 2) consumption at this building including all Fuel Oil (No. 2) meters?		☐

Additional Fuels	
Do the fuel consumption totals shown above represent the total energy use of this building? Please confirm there are no additional fuels (district energy, generator fuel oil) used in this facility.	☐

On-Site Solar and Wind Energy	
Do the fuel consumption totals shown above include all on-site solar and/or wind power located at your facility? Please confirm that no on-site solar or wind installations have been omitted from this list. All on-site systems must be reported.	☐

Certifying Professional

(When applying for the ENERGY STAR, the Certifying Professional must be the same PE or RA that signed and stamped the SEP.)

Name: ____ Date: _____________

Signature: ______________________________________

Signature is required when applying for the ENERGY STAR.

FOR YOUR RECORDS ONLY. DO NOT SUBMIT TO EPA.

Please keep this Facility Summary for your own records; do not submit it to EPA. Only the Statement of Energy Performance (SEP), Data Checklist and Letter of Agreement need to be submitted to EPA when applying for the ENERGY STAR.

Facility
Abbe Museum
26 Mt. Desert St.
Bar Harbor, ME 04609

Facility Owner
Abbe Museum
26 Mt. Desert St.
Bar harbor, ME 04609

Primary Contact for this Facility
John Brown
26 Mt. Desert St.
Bar harbor, ME 04609

General Information

Abbe Museum	
Gross Floor Area Excluding Parking: (ft^2)	15,668
Year Built	2000
For 12-month Evaluation Period Ending Date:	March 31, 2011

Facility Space Use Summary

Museum and Offices	
Space Type	Other - Entertainment/Culture
Gross Floor Area(ft^2)	15,668
Number of PCs°	8
Weekly operating hours°	60
Workers on Main Shift°	8

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 03/31/2011)	**Baseline** (Ending Date 02/28/2010)	**Rating of 75**	**Target**	**National Average**
Energy Performance Rating	N/A	N/A	75	N/A	N/A
Energy Intensity					
Site (kBtu/ft²)	117	119	0	N/A	95
Source (kBtu/ft²)	234	235	0	N/A	265
Energy Cost					
$/year	$ 48,971.89	$ 42,678.30	N/A	N/A	$ 39,749.91
$/ft²/year	$ 3.13	$ 2.72	N/A	N/A	$ 2.54
Greenhouse Gas Emissions					
$MtCO_2e$/year	164	166	0	N/A	133
$kgCO_2e/ft^2$/year	10	11	0	N/A	8

More than 50% of your building is defined as Entertainment/Culture. This building is currently ineligible for a rating. Please note the National Average column represents the CBECS national average data for Entertainment/Culture. This building uses X% less energy per square foot than the CBECS national average for Entertainment/Culture.

Notes:
o - This attribute is optional.
d - A default value has been supplied by Portfolio Manager.

Appendix B

Recommended Environmental Improvements Table with Status Updates

Appendix B: Recommended Environmental Improvements Table with Status Updates

LIGHTING & ELECTRICAL IMPROVEMENTS FOR REDUCED ENERGY CONSUMPTION

Action	**Responsibility**	**Status, March 2013**
Relamp all non-exhibit/collections spaces with fluorescent lamps at the lowest necessary wattage. • All fixtures in public spaces must have lamps. • Contact suppliers for technical assistance.	Abbe Museum staff	• In progress
Relamp Main Gallery [117/118] exhibit fixtures with lower wattage lamps. • Less wasted energy for dimming and better color rendering. • Replace existing 50W lamps with 20W or 35W lamps and similar beam spreads. • Contact suppliers for technical assistance.	Abbe Museum staff	• Current plan is to implement the redesign and replacement of gallery lighting, included in NEH implementation grant application, submitted 12/2012
Reduce electricity use and related electric utility charges, including peak demand. • Start an in-house awareness campaign of the cost of unnecessary electric power consumption. • Use local task/work lights, not exhibit lights, for local work/cleaning in Main Gallery [117/118].	Abbe Museum staff	Partially implemented, ongoing
Refit the Community Gallery [110] with museum-quality LED lamps and fixtures. • Pilot project to inform future redesign of Main Gallery [117/118] lighting. • Determine whether or not dimmer must be changed out for compatibility with LED lamps. • Investigate eligibility for energy-saving rebate. • Use pilot project for in-house testing and evaluation as well as public education.	Abbe Museum staff with Ron Harvey	• LED lamps installed in current fixtures, evaluating quality of light and energy savings
Redesign Main Gallery [117/118] exhibit lighting to improve interpretation and reduce energy use: • Apply for NEH implementation funding (2012). • Use experience for Community Gallery LED lighting pilot project. • Reduce fixture height and "wasted" light of exhibit lighting. • Consider low level ambient space lighting with LED exhibit lighting mounted in the cases. • Consider eliminating the complex theatrical lighting controls used for the Main Gallery. • Apply for NEH implementation funding.	Abbe Museum staff with Ron Harvey & lighting designer	• Current plan is to implement the redesign and replacement of gallery lighting, included in NEH implementation grant application, submitted 12/2012
Redesign Exhibition Hallway [109] lighting for lower wattage and better aesthetic effect.	Abbe Museum staff w. Jon Traficonte	• see above

PASSIVE MEASURES FOR INTERIOR ENVIRONMENTAL STABILITY TO REDUCE DEMAND ON HVAC SYSTEM

Action	**Responsibility**	**Status, March 2013**
Reduce air exchange between collections zones and non-collections zones for better RH control. • Keep doors closed (except when entering/leaving) between: Main Gallery [117/118]/Exhibition Hallway [109]; Collections Storage [012]/Collections Management Office [011]; Collections Management Office [011]/corridor [002]. • Check gaskets on above-listed doors and repair/replace if needed.	Abbe Museum staff	• Completed
Reduce temperature instability and air flow problems in non-collections zones for lower energy use and better visitor comfort. Keep doors closed between: • Orientation Gallery [103]/ Exhibition Hallway [109]; • Education Gallery [110]/Exhibition Hallway [109]. Note: the Education Gallery doors block air flow to the return air registers and block the temperature sensor when the doors are open. To keep these doors closed, the doors and hardware must be replaced for egress code compliance.	Abbe Museum staff	• Orientation gallery completed • Education gallery in process, completion expected by 5/1/13
The existing exhibit cases appear to be effective buffers for temperature and RH fluctuations in the Main Gallery [117/118]. If so, very tight control of the Main Gallery may be unnecessary and energy consumption and costs could be reduced if the environmental criteria for the Main Gallery are relaxed to a wider range. The following actions should be undertaken to evaluate this possibility: • Determine the efficacy of the existing cases for buffering fluctuations by monitoring conditions inside cases in Main Gallery. Compare in-case data to Main Gallery data and determine beneficial performance. Identify simple modifications to the cases that might improve buffering, such as gaskets. • If exhibit cases are found to be effective buffers, determine if environmental criteria for Main Gallery be changed to save energy and costs; • If Main Gallery environmental criteria are changed, determine the implications for: 1. Collections Storage [012], which is on the same HVAC zone; 2. Large, uncased objects. Evaluate the feasibility of a case for the exhibited canoes; 3. Loaned objects.	Abbe Museum staff with Ron Harvey.	• Experimentation with and monitoring of the buffering affect for various exhibit cases is ongoing, and testing of new gasketing options is planned. • Additional buffering of objects in storage is something that can be considered if necessary, but at this time, the level of control in collections storage has not been reduced, so this is not needed • Casing of large objects, especially canoes, will continue to be considered, but visitor experience and Wabanaki input on such decisions will be part of the process

PASSIVE MEASURES FOR INTERIOR ENVIRONMENTAL STABILITY TO REDUCE DEMAND ON HVAC SYSTEM (continued)

Action	Responsibility	Status, March 2013
If the environmental control criteria for the Gallery/Storage HVAC zone are changed, it may be necessary to improve temperature and relative humidity stability in Collections Storage [012]. • Test methods for buffering the stored canoes. Construct a polysheet enclosure with weighted snakes or Velcro closures, vision panels, and cotton/paper buffers below the shelving units. Monitor for 12 months (comparative monitoring with space conditions, similar to the exhibit case tests above. • Test methods to improve buffering performance of mobile shelving units. Load collections storage with buffer material (cotton or paper).	Abbe Museum staff with Ron Harvey	• At this time it has not been necessary to change the environmental control criteria; these actions can still be considered in the future if changes are made
Reduce heat loss/gain in the Orientation Gallery [103]. • Investigate interior/exterior storm windows and install.	Abbe Museum staff with Jon Traficonte	• To be completed
Reduce solar gain in Learning Lab [004]. Cooling loads in this space may be driving unnecessary chiller operation. • Install light reducing shades and keep closed except when this space is occupied.	Abbe Museum staff	• Light-reducing film has been installed, and improvements in heat gain will be evaluated when warmer weather arrives.

Appendix B: Recommended Environmental Improvements Table with Status Updates

HVAC SYSTEM IMPROVEMENTS FOR IMPROVED EFFICIENCY AND REDUCED ENERGY CONSUMPTION (ELECTRICITY & FUEL OIL)

Action	**Responsibility**	**Status, March 2013**
Reduce air infiltration into Main Gallery [117/118]; air infiltration increases humidification/dehumidification loads. • Rebalance supply and return ducts for AHU 1 (collections) zone so supply flow = return flow. • Rebalance intake and exhaust air flow through Heat Recovery ventilator HR-1.	Abbe Museum staff with David Clay	• Completed 3/5/13
Improve accuracy, transparency and human interface of HVAC controls: • Calibrate existing sensors (checked 20 April 2011). Recalibrate every 12 months. • Replace relative humidity sensors in AHU 1 (collections) zone with more accurate, more reliable sensors manufactured by Vaisalla. • Upgrade the HVAC control system software for more transparency and easier comprehension and for easier adjustment and trending of conditions and operation (approximately $10K).	Abbe Museum staff with David Clay	• Completed
Improve reliability and performance of humidifier in AHU 1 (collections) zone. • Repipe steam humidifier supply line to humidifier nozzle and provide 2 inch/foot slope for proper condensate drainage away from nozzle, per manufacturer's instructions. Reinsulate supply piping. • Test supply water to humidifier and add Reverse Osmosis-Demineralized water treatment to water supply (Humidifier model number indicates that RO-DI water is needed). • Relocate heat recovery tank and blow-down piping for easier access. Blow-down tank once per month to clear solids.	Abbe Museum staff with David Clay	• To be completed Summer 2013, during season when humidification is not needed
Modify operation of Heat Recovery unit HR-1 to improve moisture vapor control in the collections zone: • Check the enthalpy (moisture exchange wheel) for media condition and particulate accumulation. • Eliminate "free cooling" without operation of enthalpy wheel. Free cooling without the enthalpy wheel increases humidification load in winter and increases dehumidification load during cool damp periods. • Reduce outside air component to reflect true ventilation requirement for occupant load • Adjust HR-1 runtime if needed – probably only in peak season Reprogram 10 minutes per hour between scheduled visiting hours.	Abbe Museum staff with David Clay	• Completed

HVAC SYSTEM IMPROVEMENTS FOR IMPROVED EFFICIENCY AND REDUCED ENERGY CONSUMPTION (ELECTRICITY & FUEL OIL) (continued)

Action	Responsibility	Status, March 2013
Modify operation of Heat Recovery units HR-1 and HR-2 to reduce unnecessary outside air exchange and reduce energy costs: • Install variable speed drives (both units) 4 motors and modify controls for demand based ventilation ($15k grantable)	Abbe Museum staff with David Clay	• Determined that current motors have very low draw, so replacement would not create any savings/improvement
Reduce use of chilled water dehumidification with hot water reheat during seasons with latent cooling load (dehumidification) but low sensible cooling load (moderate temperatures): • Add dedicated dehumidification equipment (high efficiency direct expansion or desiccant wheel) to AHU 1 (collections) zone for first stage dehumidification. • Use chilled water system for stage 2 dehumidification.	Abbe Museum staff with David Clay	• Implementation included in NEH implementation grant application, submitted 12/2012
Reduce unnecessary heating and cooling cycling caused by tight control requirements in AHU-2 zone (non-collections area): • Raise the cooling setpoint for winter and lower the heating set point for summer for 3 °F offset. • Implement reset of hot water supply temperature for boilers based on outside air temperature (lower hot water supply temp on milder days).	Abbe Museum staff with David Clay	• Completed
Begin reinvestment planning for chiller overhaul/replacement at end of service life.	Abbe Museum staff with David Clay	• Implementation included in NEH implementation grant application, submitted 12/2012

Appendix C

The Abbe Museum's Sustaining Cultural Heritage Collections Planning Grant, panel presentation, AASLH Annual Meeting, 2011

NEH Sustaining Cultural Heritage Collections Planning Grant

Planning for the Sustainability of the Abbe Museum's Collections Environment

Julia Clark, Curator of Collections, Abbe Museum

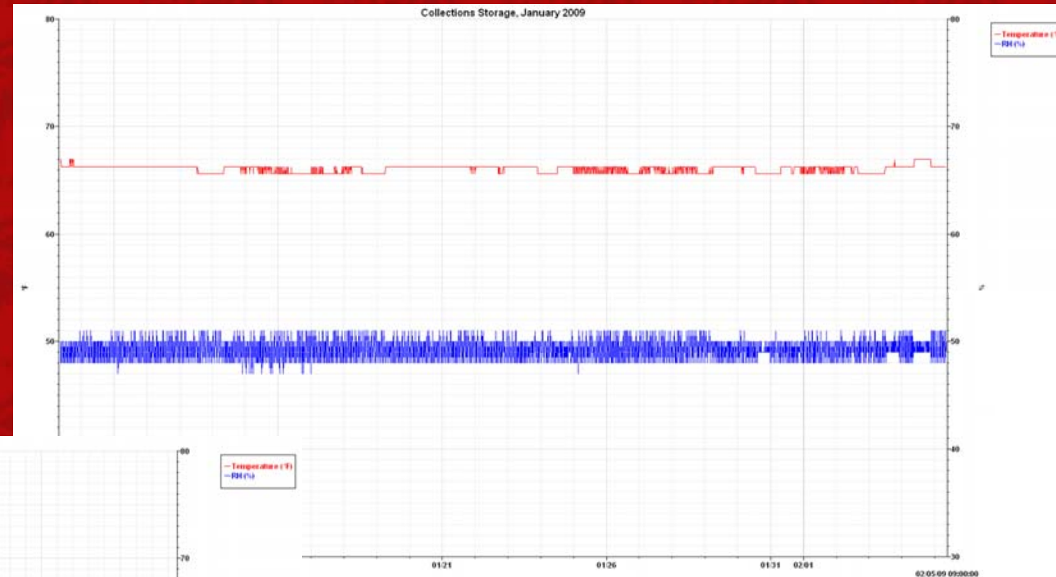
American Association for State and Local History Annual Meeting, September 16, 2011

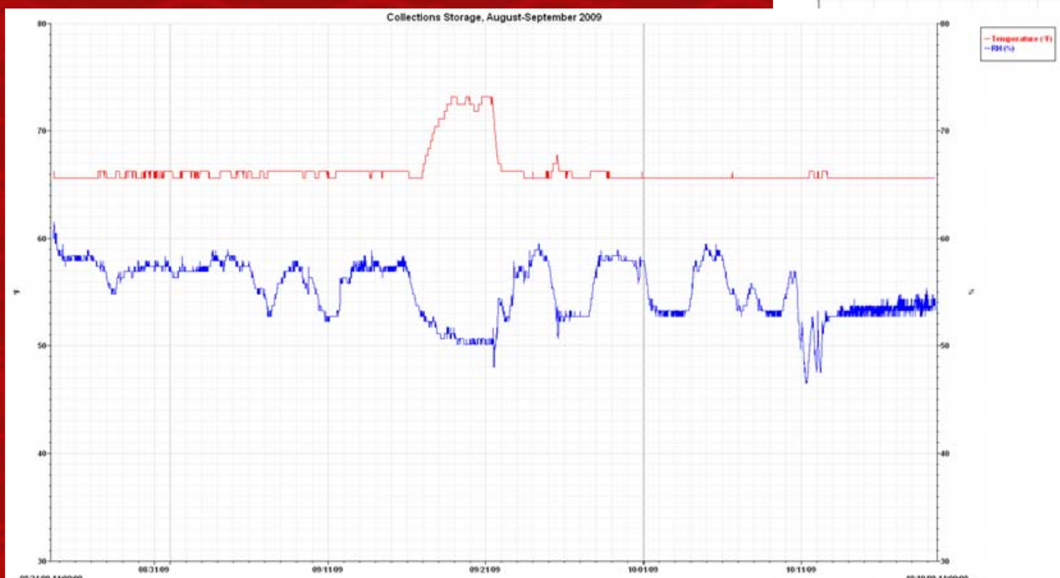
Project Team:

- Julia Clark, Abbe Museum Curator of Collections
- John Brown, Abbe Museum Director of Finance and Administration
- Michael C. Henry, PE, AIA, Watson & Henry Associates, engineer/architect
- Ronald Harvey, Tuckerbrook Conservation, conservator
- David Clay, PE, Mechanical Services/Maine Controls, engineer with HVAC service provide

- The Abbe has what was considered a state-of-art HVAC system when it was built in 2001.
- The HVAC system was not engineered by a firm with museum experience.
- While some nods towards efficiency and sustainability were made, this does not appear to have been a driving force in the design of the HVAC system.
- The HVAC system has experienced regular and frequent mechanical failures since it went on line in 2001, with some improvement in the past year or so.

The challenges…





The challenges…

Lighting & Electrical Improvements for Reduced Energy Consumption

Passive Measures for Interior Environmental Stability to Reduce Demand on HVAC System

- Use exhibit cases to buffer for temperature and RH fluctuations, possibly allowing for loosening of controls for the gallery space

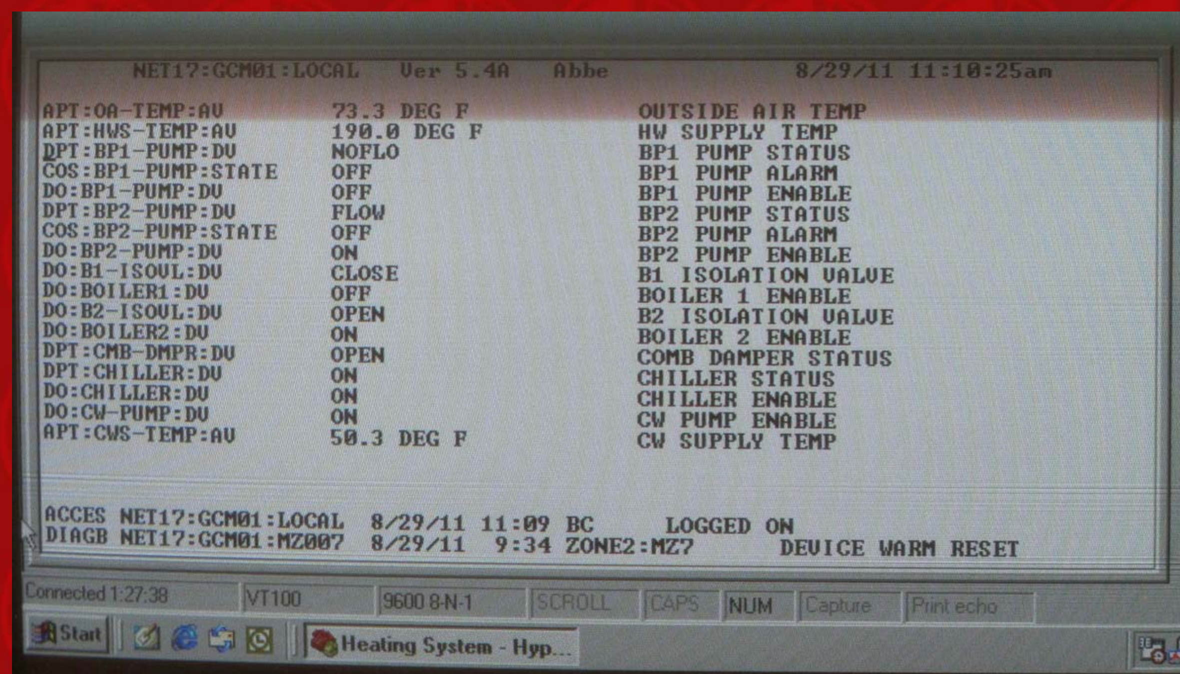
- Use exhibit cases to buffer for temperature and RH fluctuations, possibly allowing for loosening of controls for the gallery space

Passive Measures for Interior Environmental Stability to Reduce Demand on HVAC System

- Use storage materials to buffer for temperature and RH fluctuations in storage to accommodate changes in gallery space (same HVAC zone)

HVAC System Improvements for Improved Efficiency and Reduced Energy Consumption (Electricity and Fuel Oil)

- Improve accuracy, transparency and human interface of HVAC controls system



- Most of the resulting recommendations are relatively inexpensive to carry out, are imminently fundable, and will lead to both improved collections care and improved financial and environmental sustainability. We had expected a much higher price tag to make this happen.
- The Sustaining Cultural Heritage Collections Planning Grant gave the Abbe the great opportunity to completely re-evaluate a system that is big, fancy and not very old, but clearly has lots of potential for improvement, and to bring in an engineer with specific experience working with museums, to make this a valuable process

Thank you!

Julia Clark
Curator of Collections
Abbe Museum
PO Box 286, 26 Mount Desert Street
Bar Harbor, ME 04609
(207) 288-3519
collections@abbemuseum.org

Sustainable Preservation: Balancing Collections, Resources, and the Environment
American Association for State and Local History Annual Meeting
September 16, 2011

Julia Clark
Curator of Collections
Abbe Museum
PO Box 286, 26 Mount Desert Street
Bar Harbor, ME 04609
(207) 288-3519
collections@abbemuseum.org

The Abbe Museum's Sustaining Cultural Heritage Collections Planning Grant

Project Team:
Julia Clark, Abbe Museum Curator of Collections
John Brown, Abbe Museum Director of Finance and Administration
Michael C. Henry, PE, AIA, Watson & Henry Associates, engineer/architect
Ronald Harvey, Tuckerbrook Conservation, conservator
David Clay, PE, Mechanical Services/Maine Controls, engineer with HVAC service provider

Project Description:
The Abbe Museum received a $40,000 grant award in support of its ***Planning for the Sustainability of the Abbe Museum's Collections Environment*** project. The goal of the proposed planning project is to take a system-wide approach to fully evaluate the climate control system, determine its true capabilities, and look at where there may be room for improvement. The re-evaluation of targets for temperature and humidity will aim to apply new research in museum collections care, as well as taking into better account the highly variable natural environment of an island on the coast of Maine. The project will also consider and recommend environmentally and economically sustainable approaches to the building environment.

Project Background
- The Abbe has what was considered a state-of-art HVAC system when it was built in 2001.
- The HVAC system was not engineered by a firm with museum experience.
- While some nods towards efficiency and sustainability were made, this does not appear to have been a driving force in the design of the HVAC system.
- The HVAC system has experienced regular and frequent mechanical failures since it went on line in 2001, with some improvement in the past year or so.

The Abbe Museum was constructed with a reasonably tight building envelope and two separate HVAC zones – one for the collections galleries and collections storage and one for non-collections areas. The HVAC system utilizes chilled water for cooling, hot water for heating and an energy recovery unit in each zone for preconditioning ventilation air. Gallery lighting utilizes track mounted fixtures with 50W halogen lamps, controlled by a theater-quality dimmer system.

The bulk of the collections are organic materials, such as birch bark and woodsplint basketery, making them very sensitive to relative humidity change and light exposure. Most collections objects are exhibited in ungasketed cases, and the cases are not hermetically sealed. Two large objects, both bark canoes, are not exhibited in cases.

Summary of Recommendations (draft):

Lighting & Electrical Improvements for Reduced Energy Consumption

- Replace incandescent lamps with fluorescent lamps throughout building
- In exhibit galleries, replace incandescent track fixtures with (1) lower wattage fixtures and eventually (2) LED fixtures (gradually as technology improves and becomes more affordable)
- Reduce electricity use and demand through in-house awareness campaign and use of task lighting
- Overall redesign of gallery lighting system to improve energy use

Passive Measures for Interior Environmental Stability to Reduce Demand on HVAC System

- Keep gallery doors closed to reduce air exchange and reduce changes in RH and temperature
- Use exhibit cases to buffer for temperature and RH fluctuations, possibly resulting in a wider range of T & RH for the gallery space
- Use storage materials to buffer for temperature and RH fluctuations in storage to accommodate changes in gallery space (same HVAC zone)
- Install storm windows and/or light reducing shades in non-collections spaces with exterior windows to reduce heat loss/gain

HVAC System Improvements for Improved Efficiency and Reduced Energy Consumption (Electricity and Fuel Oil)

Work with mechanical contractor to:

- Rebalance supply and return air flows in problem spaces
- Improve accuracy, transparency and human interface of HVAC controls system so that staff can better understand its operation and performance
- Improve performance of humidification system by making adjustments/corrections to the installation of the steam humidifier
- Modify operation of Heat Recovery Unit to mitigate impact of outside air on inside RH, and reduce humidification/dehumidification demand
- Install dedicated dehumidification equipment in collections spaces to reduce need for cooling-based dehumidification in non-cooling seasons
- Allow wider range of temperature in non-collections areas to reduce unnecessary cycling and overcorrection during high and low temperature seasons
- Begin planning for replace of chiller, which is nearing the end of its service life

Conclusions

- Most of the resulting recommendations are relatively inexpensive to carry out, are imminently fundable, and will lead to both improved collections care and improved financial and environmental sustainability. We had expected a much higher price tag to make this happen.
- The Sustaining Cultural Heritage Collections Planning Grant gave the Abbe the great opportunity to completely re-evaluate a system that is big, fancy and not very old, but clearly has lots of potential for improvement, and to bring in an engineer with specific experience working with museums, to make this a valuable process

Appendix D

Greening the Abbe campaign material

Greening the Abbe

In the autumn of 1922, Dr. Robert Abbe was forever changed when he first saw a dozen or so stone tools in a shop window on Cottage Street in Bar Harbor. His imagination was kindled and he wanted to learn more about the people who had fashioned these stones into tools, points, and utensils…and he wanted to share what he had learned with others. His vision is what inspired the creation of the Abbe Museum at Sieur De Monts in Acadia National Park (1928).

Eighty-four years later, the Abbe has evolved into an important institution for the Wabanaki Nations and for all who visit this remarkable museum. It is a place to hear, see, meet, learn, and gain new perspectives. It is a place that continues to inspire new learning, every day. As stewards of the Abbe, we need to consider the past, create the present and plan for the future of this unique museum. As we look toward the next ten years and consider the sustainability - environmentally and financially - of the Abbe downtown, we have identified concrete changes that we can make to reduce our carbon footprint, lower our energy costs and improve our facility.

As we start our second decade downtown, using our strategic plan as a roadmap, we have identified areas in need of improvement. One of the ten strategic objectives in the plan is to maintain and improve facilities and infrastructure to support essential programs and to promote long-term sustainability. We have already started this work, and tonight our Gala Guests are invited to join us in a historic moment for the Abbe Museum when we officially launch the **Greening the Abbe** initiative during the live auction.

Our auctioneer, Dennis Damon, along with two special advocates, will lead guests through an exciting paddle raise to launch the **Greening**. This paddle raise is designed to inspire generosity and enthusiasm for this project and a number of gifts ranging from \$50 to \$5,000. Tonight, our goal is to raise \$25,000 to address the initiative's first phase – lighting, humidification, software improvements and UV reduction.

Why Green the Abbe?

Museums are unique educational institutions. The Abbe Museum has a specific role in society that must be taken into account when considering environmental impact and operational practices. Museums in general are a special case when it comes to environmental responsibility, mainly because of these four distinct characteristics: museums belong to humanity; museums are educators; museums are forums of civic engagement; museums create and transmit culture.[1] Given the Abbe's leadership role as an educational institution in the immediate community and across the state, we must take responsibility for our actions by identifying challenges, finding solutions and implementing a plan that is mindful of future generations. The Abbe should be held to a higher level of conscientiousness regarding operations and environmental impact. By greening the Abbe, we will be joining with other environmentally-conscious local institutions including the College of the Atlantic, MDI Bio Lab, Friends of Acadia and The Jackson Laboratory. Thank you for helping us reach this goal!

[1] There are numerous publications available on green design and museums, but Rachel Byers' publication *Green Museums + Green Exhibits* is a quick reference and makes a great case statement as to why museums should be more eco-friendly. Download at https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/8260/Byers_fall2008_project.pdf

Replace halogen lamps in gallery lighting with LEDs, reducing cost and carbon footprint.

Reducing energy use while continuing to provide excellent care
for our most precious collections.

Greening the Abbe

Exploring creative ways to protect collections in storage while improving the efficiency of climate control systems.

Greening the Abbe

Creating new ways to safely exhibit our birch bark canoes while reducing demand on mechanical systems.

Greening the Abbe

Installing LED lighting to reduce energy use by an estimated 88%, with a reduction of 3,390 lbs of CO_2 per lamp, while still protecting light-sensitive collections.

Greening the Abbe

Updating climate control systems to respond to demand, improving performance and efficiency.

Greening the Abbe

Re-purpose exhibit fabrication materials to reduce, reuse and recycle.

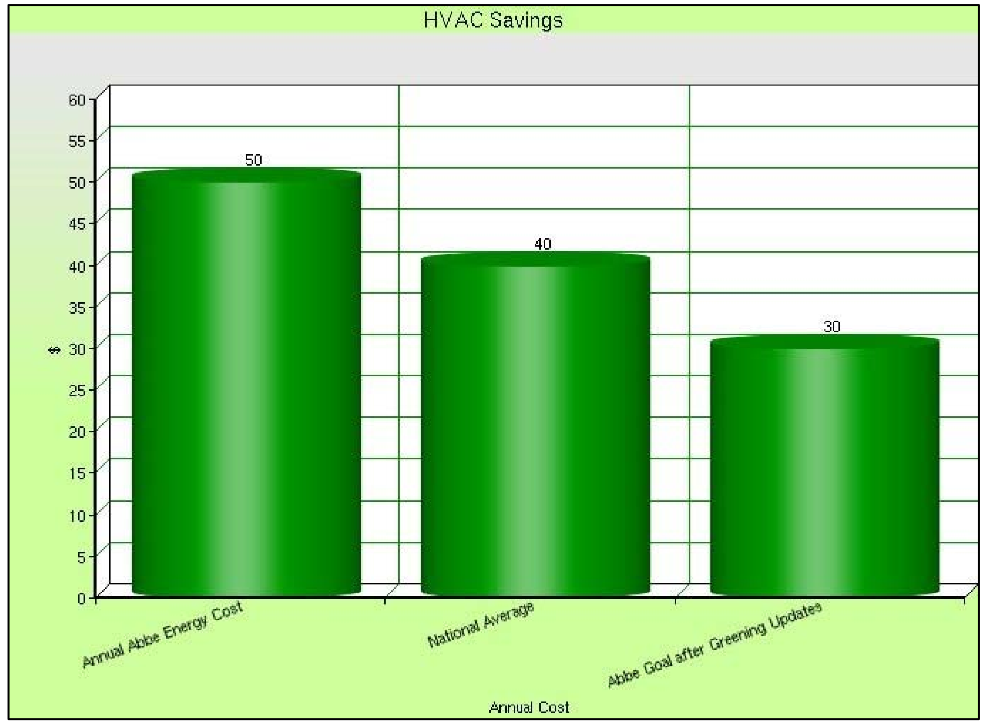
Use products made with salvaged, recycled or recyclable content to create exhibit graphics.

Greening the Abbe

Improving insulation in the historic structure to reduce heating and cooling demand and cost.

Greening the Abbe

Reduce energy use to the regional average for commercial buildings, reducing energy costs by as much as $10,000 annually.



Greening the Abbe

Improving indoor air quality by eliminating the use of toxic chemicals in museum maintenance, cleaning and care.

Increased use locally sourced merchandise, materials and supplies in daily operations.

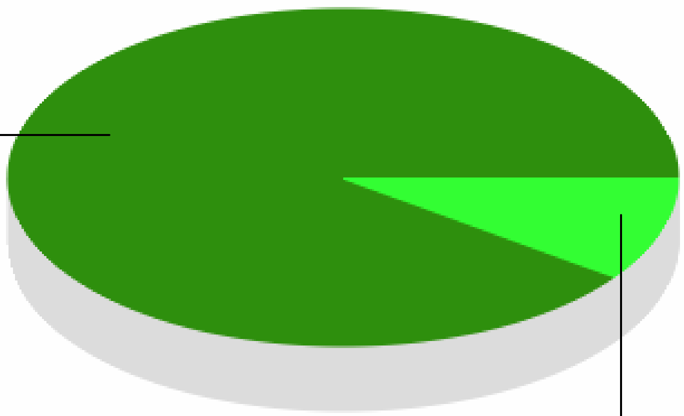
Greening the Abbe

Use recycled and recyclable paper products in daily operations, and for printing projects like your 2102 Gala invitation.

Greening the Abbe

Reducing energy use by turning off and powering down office equipment at night.

Overall Initiative Goal
$250,000



A 3-Phase Initiative begins tonight with our Greening the Abbe Paddle Raise!

Tonight's Goal
$25,000

Greening the Abbe

Greening the Abbe

A green Abbe Museum will help us to preserve and perpetuate the work we do, so that future generations can enjoy a healthy, eco-conscious Abbe Museum for years to come.

Greening the Abbe is a two-year initiative with a goal to raise $250,000 to address energy issues and green practices within the Abbe Museum. 25% of this number will be put into an endowment to help sustain our green practices.

Recommended steps for greening include:

~lighting & electrical improvements for reduced energy consumption

~passive measures for interior environmental sustainability to reduce demand on our HVAC (Heating Ventilation Air Conditioning) System

~HVAC System improvements for improved efficiency and reduced energy consumption (electricity & fuel oil)

You can help Green the Abbe!

Every bit helps! Contributions in any amount to support the Greening the Abbe Initiative can be made in three easy ways: online, using the donation forms available, or in the Abbe Shop

More information can be found at:
http://abbemuseum.org/support/greening.html

Appendix E

Abbe Museum blog post about the project

WEDNESDAY, MAY 18, 2011

Evaluating the Sustainability of the Preservation Environment for Abbe Collections

John Brown, Director of Finance & Administration

In December 2009, the Abbe entered an application for a competitive planning grant with the National Endowment for the Humanities (NEH) for evaluating the sustainability of the preservation environment for collections. In practice this means looking at our heating, air conditioning, and ventilation system (HVAC) which consumes a sizable chunk of our operating budget and leaves a significant carbon footprint. We have long had a suspicion that, in our effort to maintain a precise temperature and humidity environment, our system is often working against itself by cooling warm, humidified air in the winter and heating cool, de-humidified air in the summer.

In June of 2010 we were notified that we had been awarded $40,000 to proceed with the planning work. During the remainder of 2010, we identified professional consultants to advise on the project and obtained their commitments. We were fortunate to assemble a solid team from a diversity of disciplines that worked well together. Michael Henry is both a licensed architect and professional engineer with a specialized practice in building environments and energy management. Ron Harvey is a longtime Abbe friend and professional conservator with years of experience in materials preservation. Rounding out the team was Dave Clay who is a licensed engineer with Mechanical Services, the company that maintains our HVAC system.

The project all came together last month in several days of study and meetings at the Abbe. As a result, we obtained some immediate benefit by making adjustments to the HVAC control programming; and over the next four months we will be writing a report detailing how our system conforms to current museum best practices and remediation recommendations. This report will be the basis for a second competitive grant round for implementation including purchasing and installing equipment.

Image 1: The mechanical room of the Abbe Museum. Visitors can learn more about preservation and care of Abbe Collections in the exhibition *Objects of Our Affection*.

OUR MISSION

The mission of the Abbe Museum is to inspire new learning about the Wabanaki Nations with every visit.

BLOG ARCHIVE